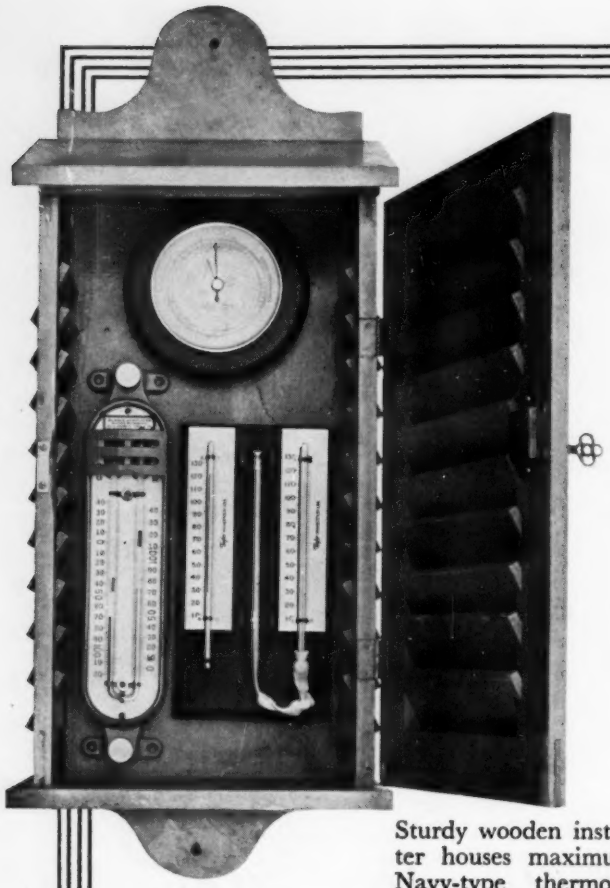
NOVEMBER 1950

THE SCIENCE TEACHER

- The Meanings of Science
- Start an Elementary Science Program—Watch It Grow!
- Making the Most of Experimental Exercises
- Travel in Outer Space

JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION



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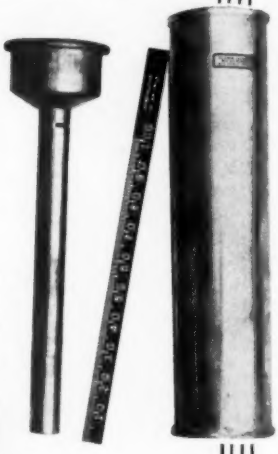

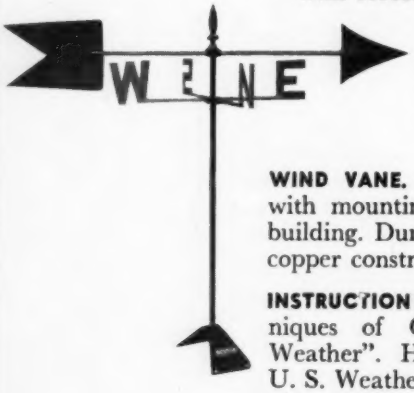

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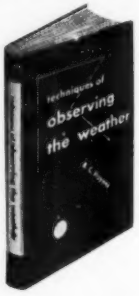

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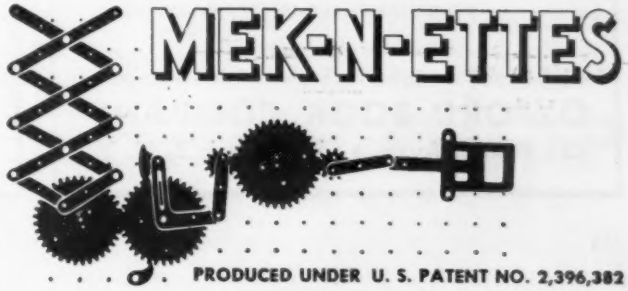

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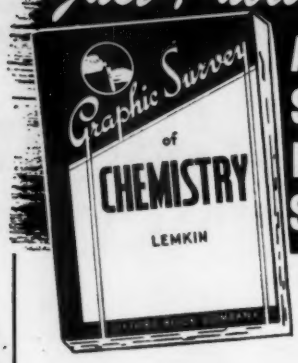

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Guided Missives

Editor, *The Science Teacher:*

The first issue of *The Science Teacher* under the new ownership of the association was so stimulating that I must write you a line to express my appreciation of this really fine journal.

I have been intending to submit some material for publication but have kept putting it off. Now the example of hard work you have set in bringing about this new birth of our official publication should shame me into getting to work on a contribution. No fooling, I will really send something in!

NELSON F. BEELER
Potsdam, New York

EDITOR'S NOTE: Hope more members will be encouraged to send in contributions. We are on the look-out for everything from quips and brief "how-to-do-it's" to longer articles on principles, methods, theories, and projects.

Editor, *The Science Teacher:*

I cannot refrain from expressing delight with the new *Science Teacher*. The October issue emerges entirely metamorphosed—a new and more powerful instrument of our association—giving every promise of development into the respected and dignified "voice" of the American science teacher.

Those who have worked to bring about the new *Science Teacher* are to be congratulated on their splendid achievement.

ZACH SUBARSKY
New York City

National Science Teachers Association:

Congratulations on the new issue of *The Science Teacher* with its changes. I am particularly pleased to find more material useful to the science teacher below the high school level and hope that this will continue.

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EDITOR'S NOTE: It will!

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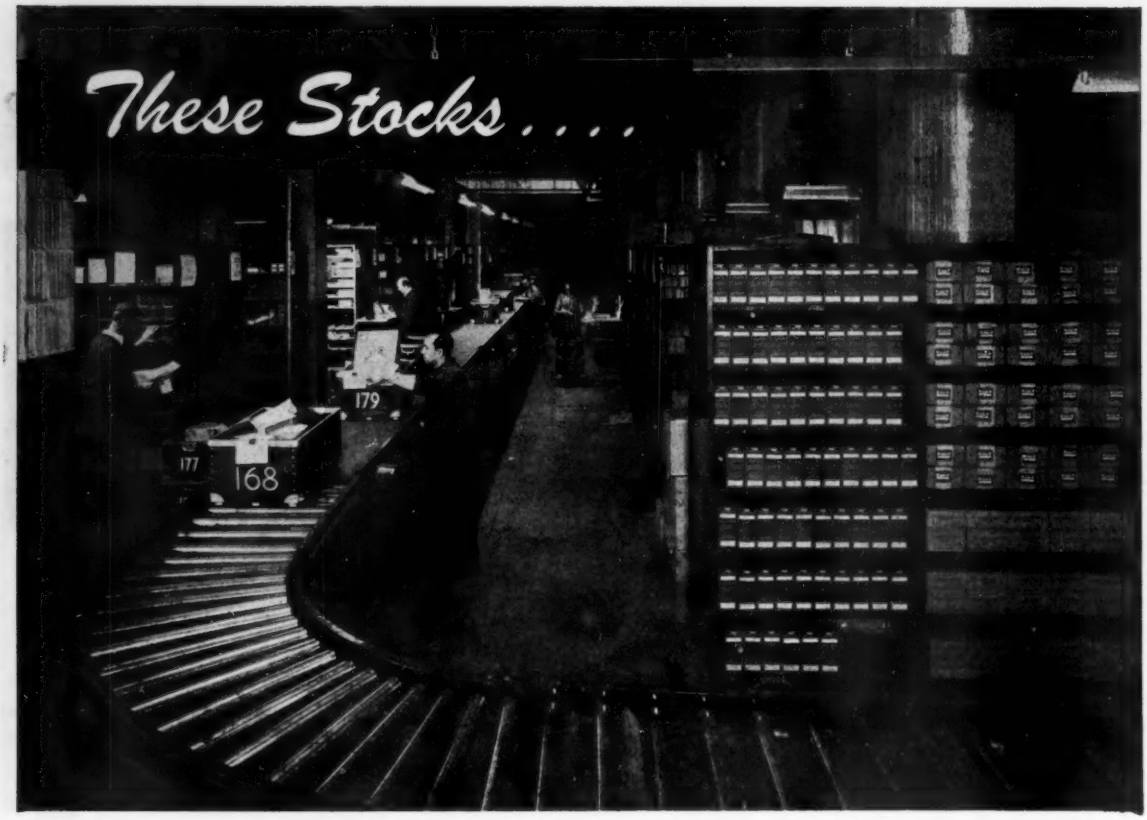

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THE SCIENCE TEACHER

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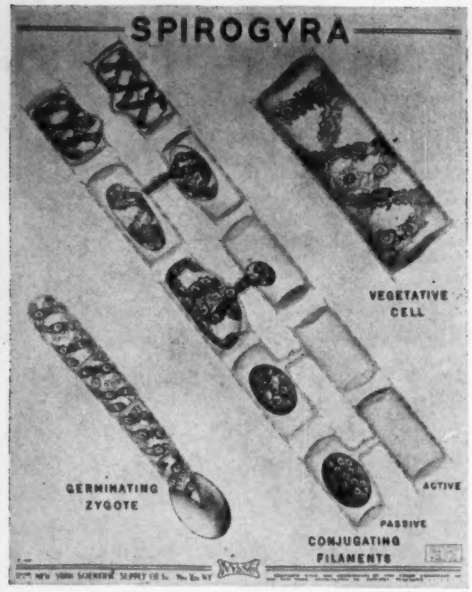

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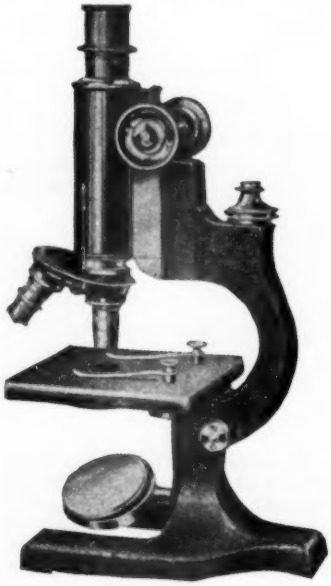

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Editorial

THE NATIONAL CONFERENCE FOR THE MOBILIZATION OF EDUCATION brought "Top Brass" from the government agencies concerned with the defense and security of the nation before representatives of nearly 100 voluntary educational associations. We heard from these government officials that we could expect to be in a condition of partial to total military mobilization for the next ten to 20 years.

A decade ago the urgency of the situation called for much specialized instruction to meet specific needs. All over the nation emergency courses and accelerated programs of study were organized. One can not predict with any degree of assurance what specialized area will contribute most to success in the present conflict. What, then, is our present need?

Robert L. Clark, director, Manpower Office, National Security Resoruces Board, states that our educational system must create a resourceful people—well disciplined, alert, healthy; a people to meet any situation. To accomplish the above, we need emphasis in the basic areas of instruction: reading and writing, listening and speaking, mathematical computation, literature, social studies, science, art, music, etc.

What is implied as regards the teaching of science?

We should upgrade our instruction: elementary, general, biological, and physical.

We should place more emphasis on the individual, encouraging him to creative thinking.

We should place more emphasis on science laboratory experience, on individual and group experimentation.

Science instruction should start early, while the child is open-minded, inquisitive, interested in finding the *why* and *how*, and dedicate itself, among other things, to maintaining such attitudes.

Attention is called to the need for screening students at the sophomore level to determine those who should be encouraged to take physics, chemistry, and the advanced courses in mathematics. This implies a sound counselling program.

Physical science at the general education level should, along with biology, be a requirement for every student. Living today, particularly living in a state of partial or total mobilization, is too dependent on scientific and technological development for our citizens to go on without understanding the basic principles of both the biological and physical sciences.

We should apply every known means to discover the potential in each individual and counsel wisely that he may develop his talents to a maximum.

What can you, an individual science teacher, do?

You can remain an alert, inquisitive, open-minded student—staying abreast of developments by an effective program of reading, attendance at professional meetings, and the continued evaluation and development of your teaching procedures.

You can study each of your students as an individual, attempting to tailor for him a program of study which will keep him working at his maximum ability.

You can make the facilities of your laboratory available to the student for his individual study at school or home on the same basis as library books are now available.

You can organize individual, group, and club activities.

You can probably increase the effectiveness of instruction through the increased use of out-of-classroom facilities.

You can develop a technique for laboratory instruction which will reduce the number of "cook-book" experiments to a minimum.

You can encourage a broad, free reading program by maintaining an adequate science section in the main library and a good science reading table in your laboratory.

You can be a teacher who is understanding and sympathetic and above all, one who inspires each student to intellectual honesty, open-mindedness, creativeness, and diligence.

RALPH W. LEFLER, President
National Science Teachers Association

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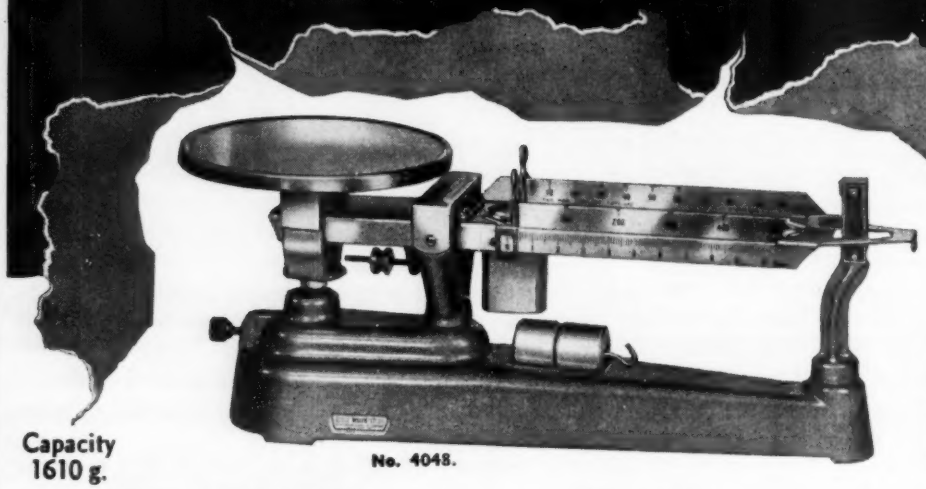

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The Meanings of Science

By PHILIP G. JOHNSON

Specialist for Science, U. S. Office of Education

We cannot escape it—all of us have some kind of philosophy and set of goals. Most of us can benefit by frequently reviewing our own understanding of what we are really trying to accomplish through our teaching. Out of his 20 years in the classroom and his more recent years in the U. S. Office of Education, Dr. Johnson has organized this stimulating guide to such review.

SCIENCE means many different things to many different persons. To some persons science means inventions and the production of gadgets, devices, and machines, while to some others it means methods of thought which are helpful in solving problems. To some persons it means organized bodies of knowledge, while to still others it means a thirst for knowledge about the unknown. All of these are partially true, but even a balanced idea of these meanings fails to reveal several important contributions of science and their implications for education. What are the major meanings for science, and what are some of the significant implications of these ideas for science education?

1. Science does mean an immense and ever-growing amount of tested knowledge about our near and distant environment; its materials, creatures, and forces. Even man himself is a proper object for study by scientists.

The educational implication is that courses of study must be given overall revisions periodically in order to drop older ideas superseded by new findings, to include knowledge that has come to be accepted after adequate testing, and to rearrange the content and sequence so as to recognize our growing knowledge concerning the nature and maturity of the learners. There is the further educational implication that teachers should be alert to scientific developments and be revising continuously their lesson materials and the related pupil activities in order to keep the science experiences up-to-date.

2. Science does mean a classification of ideas based on dependability in case the ideas are put to use.

The educational implication is that both youthful and mature citizens should be brought to realize that all spoken or printed ideas are not of equal worth and that scientific worth depends upon repeatability of results. Proper science instruction will help individuals to understand that natural laws, principles, and fundamental scientific theories have rather high worth, while hypotheses, superstitions, hunches, guesses, and deliberate lies are inferior ideas. In science studies there should be many opportunities to study and classify ideas related to actual problems so that our citizens may learn how to select and use the dependable ideas and reject and discard the weak and misleading ideas.

3. Science does mean methods of thought and work that have demonstrated truly amazing effectiveness in arriving at repeatable results.

The educational implication is that our youth, as well as older persons, should have opportunities to experience these methods in actual use until they understand and habitually apply the important elements of critical thinking that characterize the careful work of scientists. This means that the courses of study and guides used by teachers should be revised to begin with real problems, to aid in the sensing of relationships, and to require testing and applying of the ideas to many and varied affairs of personal, family, and community living. Instead of plans for teaching science *to* pupils, we need to revise our plans so that pupils may learn science by applying it to real problems. This calls for a revision of our guides for teaching.

4. Science does mean an insatiable curiosity and a thirst for knowledge about the unknown.

The educational implication is that in our professional efforts we should encourage and guide curiosity, rather than thwart it. It means that in building, remodeling, and equipping schools, we will provide space, ideally a separate room with service connections, where pupils and the teacher can use experiments in searching for answers to many of their questions. The room should be such that experiments will not be disturbed by others

while they are being arranged and used. Another implication is that we will provide school and community library materials for use by pupils in attempts to satisfy their curiosity. It means that teaching methods will provide encouragement in proposing real and vital questions and that there will be time and facilities for pursuing many of these questions. No teacher can answer all inquiries, but the wise teacher will encourage them and help youth to find answers to many. Teachers need to feel that the process of finding answers is commonly more educative than the giving of ready answers. The educational implication that there should be less class teaching and more effort to help pupils learn by and for themselves emphasizes the need for learning how to use projects as a part of teaching.

5. Science does mean a cooperative undertaking—a team job where ideas and results from the efforts of many persons are related to a common problem or goal.

The educational implication is that science teachers and other educational leaders will so plan their methods and content that groups of pupils may work together, combining their talents and experiences in planning means and methods for achieving a common goal by cooperative endeavors. Where classes involve 30 or 40 pupils, the implication is that the teacher will, through study and experience, become skilled in developing study guides so that several groups of a few pupils may each be working simultaneously on phases of a common problem. The implication is that science teachers will use class procedures less and group procedures more in the teaching of science.

6. Science does mean certain attitudes and standards which help persons to safeguard themselves from making errors in finding, selecting, and using evidence.

The educational implication is that we in our schools should be sensitive to the hazards of using conclusions based on meager evidence, of accepting ideas of others without knowing very much about the experimental bases for the ideas, of attaching undue value to ideas which favor desired results, and the like. Not only should we be sensitive to these and other scientific attitudes and standards, we should so teach that pupils will develop and come to be influenced by similar safeguarding attitudes and standards. This means that we should do less talking about scientific attitudes and engage more pupils in the individual consideration of ideas where they will have opportunities to select and use the ideas of others, as well as ideas that come to them from experimentation. It also means that we as their teachers will be cautious about jumping to conclusions, that we will try to avoid being overly positive about ideas that we put before pupils, and that we will endeavor to be objective in our evaluation of the ideas of others. Again this will mean that we will teach less science *to* pupils and, instead, help pupils to *develop* standards through the studies and experiments which we guide them to do.

7. Science does mean a multitude of gadgets, devices, materials, and machines that help to relieve man of discomfort, drudgery, and constant attention to repetitious tasks.

The educational implication is that pupils should be brought to see, as a part of their regular and common studies, how improvements in applied science grow, each building upon previous application and each representing an expanded understanding of the fundamental facts and principles of science. It means that pupils should be brought to sense areas of human need related to work, illness, enjoyment, and the like, so that they will be challenged to think creatively about using science for human welfare. While few students in high school may make noteworthy inventions and discoveries, most will find it educative and enjoyable to understand how science is applied. Some pupils may, as they advance in knowledge and skill, come to make important improvements in applied science. A consideration of applied science will add to the pupil's feeling that science studies are directly valuable, and it will also prepare pupils to live in a world of changes without being overawed by the achievements of science. To use this meaning of science significantly, courses of study and lesson materials will have to be revised by enriching them with many and varied examples of applied science and technology and guiding pupils to apply their knowledge of science to a study of how their devices and materials operate.

8. Science does mean ways of improving on what happens naturally. It means removing or adding certain hindrances and adding or removing certain aids to changes.

The educational implication is that curriculum leaders and classroom teachers be alert to the many ordinary things that happen around all of

us so naturally that we often take them for granted. Many of these should be made a part of science studies in order to determine the factors involved and how the changes may be controlled for human betterment. Erosion due to weathering makes a frightful cut into our natural and man-made resources. Illness and accidents cause much needless loss or impairment of life. Flowers and crops suffer from lack of needed plant food and moisture or from disease infestations. Many members of the human family appear to be the victims of natural calamities due to storms, droughts, diseases, disasters, misunderstandings, and the like. Teachers can make these the object for study to reveal the real scientific causes and factors involved and to challenge youth to plan for their control through the use of science. Like the other meanings of science this will require certain rather fundamental changes in science content and organization, as well as changes in methods of teaching.

9. Science does mean values that give direction and purpose to man's scientific endeavors.

The educational implication is that we should be cautious in repeating the trite statement that science is neutral, and consider the several respects in which science is not neutral. While it is true that science is a powerful tool which may be used for human good or evil, it is also true that science is based on truth, and therefore truth is of supreme importance to scientists. Furthermore, we often fail to emphasize that many scientists, notably the medical scientists, are devoted to the prolongation of life. These scientists live by the ideals that human life, any human life, is worth preserving and that health is preferable to illness. These ideals —that truth is of first importance, that health is good, that human life is worth preserving, that the pursuit of science is a worthy endeavor—represent aspects in which human values are involved in giving direction and purpose to scientific endeavors. These ideas can be emphasized along with the idea that scientific facts and principles are neutral.

10. Science does mean an humbleness of spirit in the face of the many unknowns that surround us, and it does mean an appreciation for the devoted work of other persons upon which we now can build.

The educational implication is that we should give perhaps more attention than we are now giving to the history of science, both past and current. This means that we should examine our courses of study and other teaching suggestions to note how well we are emphasizing the devotion of multitudes of research workers who, in the past or now, probe the many unknown diseases, unknown changes and their probable causes, unknown processes and factors in their control. It also means that we need to emphasize how new knowledge reveals a host of problems to be restudied in the light of the new knowledge. It means that we should bring our pupils to sense that time is long and problems unending and that any person's life is all too short to arrive at final answers. It means that pupils may begin to sense the idea that life itself is the pursuit of truth in relation to hypotheses concerning human existence.

When we survey even briefly some of the possible meanings of science, and their educational implications, we begin to sense the great values that science can have in the education of our youth. We begin to realize that organized science teaching and science learning should begin with children in the early elementary levels and continue by sequential and meaningful experiences through the years of required schooling. It means that these science experiences should be so directed that science becomes operative in habits of thought, as well as in knowledge and values. It means that learning should be guided so that science may continue to be an area that challenges persons to engage in informal study and learning throughout life. To achieve or even approach such outcomes, we must constantly and thoughtfully revise our science courses, enrich our teaching materials, develop our physical arrangements for study, and improve our plans and methods of teaching.

"It ought to be evident that . . . (the student) would go to the laboratory just as the scientist does—*to find out at first hand by special appropriate observations and experiments certain essential facts of observation which he needs in the methodical investigation of a scientific problem, and which he cannot so conveniently or effectually find out elsewhere. . . .* Much of the work that is being done in the name of laboratory study is almost worthless. . . . *Probably there is not a college anywhere in this country that would refuse to admit a student who is well grounded in the elementary principles of science and who presents a good laboratory course in which such material is replaced by more significant kinds of laboratory work.*" So wrote George R. Twiss in PRINCIPLES OF SCIENCE TEACHING, *first published in 1917.* And he was not, by any means, the first to call attention to the earmarks of good laboratory teaching.

Experimental Science

—Brief History and Present Outlook

By JOHN S. RICHARDSON

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IT IS a paradox that in an area of human activity which is based upon experiments, the teaching itself has not been experimental. Science in the elementary and secondary schools in America has not been experimental either from the point of view of the method of teaching or its relation to the remainder of the curriculum. The study of science in both elementary and secondary schools has been largely the memorization of content.

The laboratory in the secondary school has been used primarily for the observation of facts and phenomena already known and for the verification of data and principles. A few efforts have been made to use the laboratory for real experimentation, and a portion of these efforts has been successful. However, the heavy loads on the teachers have fastened upon them the laboratory manual, which is too often a stereotyped set of directions to be followed line by line with no opportunity for student initiative.

In the elementary school the extent of science in the curriculum has been quite limited, and this has been mostly of the kind of work that would be classified as nature study. It has utilized direct observation but little experimentation. The general conception of the elementary school curriculum has not included science in any particular aspect, much less student activity, in the way of experimentation.

The concern that science be taught by experimental procedures, that learning should come through direct experience, is not new. In the United States the foremost protagonist of functional learning in recent decades has been John Dewey. The implications of his philosophy for objectives and methods of science teaching are clearly discernible: "The obligations incumbent upon science cannot be met until its representatives cease to be contented with having a multiplicity of courses in various sciences represented in schools and devote even more energy than was spent in getting a place for science in the curriculum to seeing to it that the sciences which are taught are themselves more concerned about creating a certain mental attitude than they are about purveying a fixed body of information, or about preparing a small number of persons for further specialized pursuit of some particular science" (**10**).

There is also evidence of concern for direct experience in the secondary school. The Forty-Sixth Yearbook of the National Society for the Study of Education (**19**) advises a wide use of materials, equipment, and multisensory aids in biology (page 186), the teaching of chemistry through a direct problem approach, such as consumer chemistry (page 206), and the use of techniques and materials to avoid lock-stepping (page 208). The same source also advocates the extensive use of clubs and direct experiences (page 229) and the use of community resources in the teaching of secondary school science (page 233). The role of the laboratory is seen to be three-fold: (1) to raise and define problems; (2) to learn the meaning and use of controls; and (3) to test hypotheses and interpret data.

The concern of science educators is expressed by Cahoon who sees the demonstration as an occasion to teach for thinking, as well as an exposition of facts or relations (**7**). He points out that the use of an experimental approach to learning depends upon the competence of the teacher. On the basis of the needs of teachers he made a survey of the necessary competency, as well as an outline of a general plan for providing it (**6**).

A technique of evolution from formal teaching of physics to the use of the experimental approach is described by Lefler. Problems which interested and concerned the students and which involved facts, concepts, and principles in the field of physics were the basis for planning and experimentation by the students. The potentialities of this approach to science teaching, as well as the implications for required competence in the teacher, are clearly reviewed (**14**).

Perhaps the most widespread use of the community by high school science classes is in the study of conservation. Such studies have been related generally to biological science and general science. In a rather extensive study growing out of the activities of the Bureau of Educational Re-

search in Science, Laton and Powers describe several situations in which the science courses were directly and carefully related to the communities in which the schools were located (**13**). In the Cranbrook School (near Detroit), the chemistry and the economics of the community life were related. In the Hammond (Indiana) schools, the biology and chemistry were related to the industries of the community. In the Glens Falls (New York) schools, the biology was taught in relation to the changing pattern of natural resources of that community. In the Greeley (Colorado) schools, the science emphasized the relationship of the land to the people. However, because of the tradition which tends to bind it, the secondary school is somewhat slower to use community resources than the elementary school.

Many classrooms in the elementary school are making their contribution to the experimental approach to learning. A situation is described by Boer, who directed the experimental work of children in the primary grades, in solving such problems as—Can anything live without air? Does air take up space? Can air push? Is air strong? (**3**). Similarly, Podendorf describes a situation in which fifth-grade children assisted in planning a unit in electricity and used the equipment in carrying out their plans (**17**). The work utilized common problems—Why do lights go on when the button is pushed? What do batteries have in them? What causes lightning?

The use of direct experience in learning science in the secondary school is a major concern of many students of science education. The necessity for planning courses to meet felt needs of students and to serve their general education has been discussed by Carleton (**8**). Similarly, Johnson expresses concern that physics courses (and, by implication, other courses in high school science) be planned in terms of the students' problems, and that they be encouraged and guided to use scientific methods in solving these problems (**12**).

The use of problem situations has received attention from many quarters. For example, Bergstrom reports the work of a high school student on the effect of increased amounts of testosterone on the male animal (**2**). White mice were used in this research which was being carried on independently by a high school student. In other situations the work is essentially of a problematic character, even though it is not necessarily basic research. In the Southwest High School of St. Louis (Missouri), experiments in plant and animal nutrition have been the concern of high school students. The effects of nutrients and growing conditions have been studied.

Johnson describes a situation where experimentation resulted from problems which arose during the critical soap shortage (**11**). Ninth-grade students added soap solutions volumetrically (by means of medicine droppers) to samples of water. They compared results with great interest, noting corresponding results with certain samples of water and different results with other samples. Many problems close to their lives grew out of this observation—Were the samples of water the same? How could water be treated to save soap? Did service stations use distilled water for car batteries? Many separate projects resulted, involving water softening in the home, costs of soap and soap powders, and the like, and the reports made in class resulted in still other class activities.

Obourn similarly describes class experimentation which resulted from a problem which confronted all students (**16**). A class in health biology became interested in a rather prolonged newspaper discussion on the "pros" and "cons" of a proposal that the city authorities do something about the apparent unsanitary conditions in public eating places. These accounts were brought to class each day and analyzed for facts and assumptions. Finally the class accepted and defined three or four problems which they regarded as significant. These

The Natural Sciences Department of UNESCO has recently undertaken the important task of preparing and distributing a series of papers intended to stimulate discussion on the responsible and difficult goal of "teaching for thinking." First in the series was an invited paper authored by Dr. Richardson. Reproduced here, with the permission of UNESCO, is an abstract of this thought-provoking document.

One of the best ways of moving toward our goal, it would seem, is to make pupils actively acquainted with the scientific approach to things. How can this best be done? What has been the experience along this line in the United States? What kinds of experimentation are under way today in regard to new directions for the experimental teaching of science?

To find the answers to these and other questions, Richardson has made a careful and searching examination of the literature and has drawn upon his own wide experience and observations. His findings have been recorded succinctly, but clearly, in the 25-page, mimeographed UNESCO publication. Included is a bibliography of 64 items. Teachers interested to have a copy of the complete report may obtain one free of charge by writing to the Natural Sciences Department, Division for the Dissemination of Science, UNESCO, 19 Avenue Klebér, Paris 16, France.

problems dealt with the cleanliness of the hamburger places and soda fountains. In the process of discussion, the students had to arrive at definitions as to what constitutes cleanliness. They decided that the one way to get information was by observation and experiment.

Sterile culture plates were made, and the students set out as an invading army for the local soda fountains and hamburger places. They exposed the cultured plates to the air in these places. Permission was obtained from attendants to expose the cloths with which they wiped the counters. The cleanliness of the attendants' clothing, as well as their hands and finger nails, was noted. The students observed floors and took cultures of dishes that had been washed. Two boys even went to a popular hamburger shop after closing hours and obtained a flashlight picture through the window of cats on the counter inside.

The cultures were properly grown and compared with control cultures. The students asked that a bacteriologist from the county health department come to the class and examine their evidence and help them identify some of the bacteria on the plates. They made pure cultures of some of the bacterial strains, stained them, and identified some of the more common types.

Perhaps the most interesting and significant outcome occurred when the class, without the knowledge of the teacher, decided to take some action. This action took the form of: (1) letters written to local papers, all of which were published; and (2) letters written to the places that had been found to be unsanitary, threatening boycott unless certain practices of good sanitation, which were set forth in the letter, were instituted. The result was a very sharp and observable clean-up of almost all of the hamburger and soda places which were frequented by the students.

An interesting experimental approach in classes in physics is that described by Nelson (**15**). A practical problem is posed, such as—What is the best kind of vacuum cleaner? A variety of equipment is available (vacuum cleaners, rugs, electrical meters) designed to test the efficiency of cleaners and the cost of their operation. The students plan and carry out their own work. In doing so, they face the necessity for careful planning, accurate work, and valid conclusions.

Brandwein describes research on the high school level in the Forest Hills (New York) High School (**4**). He lists such problems as the germination of zygospores of bread mold, the relationship of Dero to protozoa in microponds, the effect of vitamin deficiency on pill bugs, and the like.

Many kinds of reorganized courses can be found. Ruchlis reports a correlation of physics with social studies utilizing the gap between man's knowledge of science and his lack of knowledge as to the social implications of technology as a starting point (**18**). The problem was pursued on the basis of the low cost of power as related to manpower and the resulting social problems.

Various combinations of science courses have been developed. One of the more common of these has been an effort to functionalize physics and chemistry, as well as other physical sciences, by planning an integrated course in physical science. This has commonly been a one-year course, although there have been some instances of a two-year sequence. The development has been slow for perhaps two reasons: (1) the lack of understanding of teachers as to how to proceed; and (2) uncertainty concerning the acceptance of such courses for college entrance. In relation to the latter factor, Carleton found conclusive evidence that colleges will accept such courses in meeting entrance requirements (**9**).

A careful experimental study of a physical science course was made by Brown (**5**). The study centered around interpretative generalizations of the general field and provided for studies growing out of direct experience planned by students and the teacher. The report, based on experience, shows clearly how readily the content of the physical sciences can be brought together in the solution of problems significant to students.

The effort to move from mastery of subject matter to the production of desirable changes in behavior as a major objective of education has resulted in many efforts of various kinds to break down subject matter boundaries. A significant development in this direction is the core curriculum, which has been defined by Alberty as "that aspect of the total curriculum which is basic for all students and which consists of learning activities that are organized without reference to conventional subject lines" (**1**).

In a certain sense the curriculum of the elementary school may be interpreted as "core," and, by common consent, basic education for all students. The core curriculum of the secondary school generally embraces English and social studies as being the basic areas for all students. However, the place of science in the core is not well defined as yet. The science which appears in the core program is largely on the seventh, eighth, and ninth grade levels and is somewhat similar to general science.
(*See* EXPERIMENTAL SCIENCE, *page 197*)

Start an Elementary Science Program

—And Watch It Grow!

By CLARK HUBLER
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and
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VIRTUALLY all the literature today recommends that science be a part of the program for young children,[1] yet there are problems to be overcome. One of the obstacles is an uncertainty regarding where to begin and how.

In one classroom of eight-year-olds, science instruction began when a child showed the others a broken piece of glass. Gail had been to the seashore during the summer and had brought back the fragment of glass, worn and rounded by the waves. While the broken particle was shown to the class, the children talked about how, very likely, it once had been jagged, with sharp edges, and how the movement of the waves had dulled the edges by rubbing them against the rocks and sand of the beach. Comparison was made with the freshly crushed rocks of a nearby driveway and with the well-rounded rocks of the beach and stream. The next day another child brought from home a freshly broken piece of glass, the edges still sharp, not worn as the other had been. Also someone noted that the steps at the front of the building were of stone and had become worn where people had walked upon them.

Thus began a concern for rocks and the effects of erosion. A modest beginning for science, but one experience followed another, and a well-balanced science program appropriate for the children was developed. To begin, it was necessary for the teacher to see that the child's fragment of glass could lead the class to worthwhile learnings, and that consequently the interest was worth encouraging.

A glimpse into the science activities of an actual kindergarten class on a certain winter day may serve to illustrate some of the possibilities. On this day Sandra watered the bean seedling she'd planted earlier when seeds were gathered in the fall. Corolla and Susan were making a book about magnets, with which they'd already had some experience. They made pictures of magnets picking up things and dictated to the teacher the story they wanted printed under the picture. These two girls were busy experimenting with the magnets, because they wanted more information for their stories. At the teacher's suggestion, Susan, in her account, told what a magnet will pick up, as well as what it will not; for example: "Magnets will pick up nails." "Magnets will not pick up chalk."

Four or five children were gathered about the hamsters' cage watching the nest-building activity of the animals. The children had brought food from home for the hamsters, and the milk bottles from the morning lunch were drained to supply the animals.

Marjorie saw Corolla and Susan making a book and so wanted to make one too. The teacher helped her plan by mentioning a number of possibilities. She decided to make a book showing the seasons. On previous excursions the class had noted the changing conditions outside. Her first picture was of a green tree and a girl in a purple dress and the story she dictated was: "In the summer leaves are green. We play out in the sun." That was all she cared to do in one day. She expects to picture other seasons on another day.

[1] Hildreth, Gertrude. *Child Growth Through Education*, pp. 156–158. Ronald Press. New York. 1948.

We have often heard elementary teachers say, "I'd like to include some science in my teaching, but I don't know how to begin." The authors of this article suggest that the answer is, "You can begin almost anywhere in the curriculum and with very simple materials—a rounded pebble, a change in weather, a magnifying glass. Moreover, you can begin science with even the youngest." This article offers numerous practical suggestions and ideas for adding "science fundamentals and overtones" to the elementary curriculum.

Sandy wanted to make a book about the hamsters, but after sitting down looking at the empty paper for a while, decided he didn't want to do it just then. Thinking hamsters were too hard to draw, the teacher suggested to make a book without pictures, but Sandy decided to join another group in the room.

Ernest carried the magnifying glass about the room for a while. He looked at a book through the glass, at crayons, and he peered through the lens into the aquarium. Apparently he sought to find out if the glass would magnify all things, or like the magnet in the room would work only with certain materials.

Childhood interest and curiosity provide a good starting point for elementary science. But more factors than these are needed to build a program; and more than one plant is needed for an experiment.

David was stacking blocks, not strictly a science activity, but he was learning something about gravity. Likewise, the class talked about the calendar that morning, since it was the first school day in January. The discussion served to clarify experiences and stimulate further observation of the changing seasons.

The activities recounted are informal, and not all are strictly science activities, but that is as it should be. Ideally, science is an integral part of the larger curriculum, rather than standing alone in the daily program.[2]

There are many ways to begin the work in science. The teacher may simply plan with the children, in groups or as individuals, and decide what would be worthwhile to do. The anticipation involved in planning can serve as a stimulus to the children. The planning can also be instructional in itself by helping the children to see purposes and relationships as they plan. The teacher should have a few suggestions already in mind, and the children may think of other possibilities. With small children it is wise to avoid confusing them with too many alternatives; if one suggestion is good and acceptable to the children, it can be acted upon without considering other possibilities which the teacher may have in mind. The planning may involve a problem: Snow brought into the room melts; where did it go? A pan of water left on the radiator is soon empty; where did the water go? Perhaps experiments can be devised to solve the problems. If Michael suggests that the pan may have leaked, another pan could be placed beneath it. If someone thinks the water may have gone into the air, the pan, or another like it, may be covered with a plate, a sheet of glass, or whatever is available, and a comparison made. The results will be even more illuminating if several pans are used, or if the experiment is repeated a number of times with the same pan.

It may be that some event within the child's immediate surroundings will stimulate inquiry: a lineman from the telephone company may be working on a pole outside the school, stimulating interest in how an electric current can be carried along wires; or a power shovel may begin to work in the street or on a vacant lot, and the children can learn how machinery helps people in their work. The weather is usually unusual enough to excite comment, and there are many possible learnings suitable for children, such as: What makes the wind blow? How does rain come from clouds? How does a thermometer work? Or for the youngest, the mere fact that the weather does change is noteworthy, and that there actually are such things as air, and wind, and fog, and clouds. A snowfall may prompt the children to bring a pan of snow into the classroom and thus learn that snow is a form of water. As sometimes happens, the children may decide to put the pan back outside, and so learn that ice is formed, rather than

[2] National Society for the Study of Education. *Forty-Sixth Yearbook, Part I, Science Education in American Schools,* p. 70. University of Chicago Press. Chicago. 1947.

the snow they had anticipated. At another season the class may go onto the school grounds after a heavy rain and note that running water has cut gullies in the flower beds—a first lesson on erosion. Immediate events, significant to the child, can stimulate inquiry and help the child to understand his environment.

The interests, understandings, and capabilities of children are manifest in the questions they ask, the topics they discuss, the materials they bring to class.[3] The inquisitive spirit of childhood is proverbial. The question of the moment may be: Where is the sun on a cloudy day? How high are the clouds; higher than an airplane? Higher than the moon? How can airplanes fly through clouds? Does the rustling of leaves on the trees cause the wind to blow? Functional learning in science can result from such questions.

Frequently the work in science may be an outgrowth of previous activities, either in science or in other phases of the program. A trip to a farm, commonly a social studies activity, is suggestive of many possible learnings in science. A study of the local fire department is another example. In turn the science can contribute to a greater appreciation of the work in other areas.

A field trip is often an excellent way to create interest and initiate a study of science. In the autumn, for example, seeds can be gathered, the falling leaves noted, along with the absence of familiar birds, and the fact that the sun is low on the horizon even at midday. In the spring new growth on the bushes and trees can be examined and the changing seasons again noted, leading to an understanding of how plants grow, how the seasons change, and how the birds are returning after their migration to the south.

One of the most common and effective ways of stimulating interest is to place a display of appropriate materials upon the table where the children can handle them. A magnifying glass, magnets, or a thermometer, among others, are suitable for such purposes. An animal, such as a hen, a rabbit, a butterfly, a tadpole, or a salamander can serve a similar purpose. A suitable cage can be fashioned from screen wire for the small animals, from chicken wire for the larger ones, and the animals need be kept but a few days for most purposes. Real materials brought to the class by the children or by the teacher stimulate interest and can serve as one way of initiating science work. A broken piece of glass was the stimulus mentioned above. A broken or rounded pebble in some respects might have been even better. Other possibilities are virtually unlimited: A mechanical toy, for example, or a caterpillar, a kitten, an acorn, perhaps a musical instrument. All could lead to worthwhile learning in science.

The broad purpose of science for children is to help the children interpret their surroundings and make intelligent adjustment.[4] Ordinarily such interpretation and adjustment is part of a gradual process based on many experiences and involving gradually expanding concepts. The best programs are apt to grow from simple beginnings. One experience leads to another. The entire program need not, should not, be initiated all at one time. The teacher who waits to understand all of science before beginning is not likely to begin. The history of science itself shows that progress is made through attacking one small problem at a time, rather than by waiting for over-all mastery.[5]

A few reference books, such as those in the list which follows, can be helpful to a teacher in getting started.

[3] Stratemeyer, Florence B., and others. *Developing a Curriculum for Modern Living*, pp. 301–311. Bureau of Publication, Teachers College, Columbia University. New York. 1947.

[4] *Ibid., Science Education in American Schools*, p. 60.

[5] Dampier, Sir William Cecil. *A History of Science*, pp. 141–42. Macmillan Company. New York. 1946.

Suggested References

1. Craig, Gerald S. *Science for the Elementary School Teacher*. Ginn and Co. Boston. 1947. 561 pp.
   Gives information suitable for the teacher's own background of understanding and suggests numerous experiences for children. Part I is concerned with the point-of-view in science for elementary schools. Is probably the most generally useful book available.
2. Brem, Peter. *An Aid to the Teaching of Science: 100 Simple Scientific Experiments for Children in the Grades*, Book I. Kenyon Press Publishing Co. Wauwatosa, Wisconsin. 1937. 46 pp.
   As simple and practical a group of experiments as any available, involving all areas of science.
3. National Society for the Study of Education. *Forty-Sixth Yearbook, Part I, Science Education in American Schools*. University of Chicago Press. Chicago. 1947. 296 pp.
   Section II, pages 60 to 136, are concerned specifically with science in the elementary school: its importance and purpose in the curriculum, the organization, materials, and methods of instruction.
4. *Science Teaching Today, Vol. I, Experiments With Water*. National Science Teachers Association. 1950. 48 pp.
   Eight units made up of 34 carefully tested experiments with water to supplement regular class activities at upper elementary level. Complete directions and explanatory diagrams accompany each experiment.
5. *Science Teaching Today, Vol. II, Experiments With Air*. National Science Teachers Association. 1950. 44 pp.
   Five units of 27 experiments with air provide lively and interpretive activities covering the nature of air, its importance, and uses.

Making the Most Of Experimental Exercises

By ELLSWORTH S. OBOURN

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COLLECTING and testing evidence by experiment is perhaps the most specific thing that sets science apart as unique in the whole field of learning. Scholars in the history of science commonly date the rise of modern science from the classic experimental work of Galileo and his contemporaries. The masters of science who have followed Galileo down through the years have frequently attained their enviable positions because of a resourcefulness in the ability to devise ways of testing the truth or falsity of hypotheses.

In the experiment, the science teacher has at his disposal one of the most potent devices of learning ever devised by the mind of man. There is some evidence to support the contention that science teachers at the ninth-grade level are not fully aware of the potentialities of the experiment as a device of learning and therefore use it ineffectively. In other science subjects the few experimental exercises in which control factors are now used is testimony to the inadequacy of the experiment as an effective device for learning.

Since teachers generally seem to teach the textbooks which are selected for their courses, it may be true that textbook writers will have to revise their conception of the nature and purpose of the experimental exercise before much can be done toward improvement in the science classrooms over the country.

The true function of an experiment is to furnish evidence bearing on the truth or falsity of some factor, the influence of which is being tested. What do we mean by evidence? One of the best statements directed toward an answer to this question was made by Henshaw Ward some years ago in the Harvard Teachers Record. He wrote:

> Science cares only for indisputable evidence. If the evidence is conflicting, science balances the probabilities without running headlong to a conclusion. Unless the evidence so cumulates that almost all competent observers are forced to agree, science suspends judgment! How salutary it is for any one of us to learn to suspend! Whenever new evidence appears the true scientist welcomes it; he is as ready to have his previous theory demolished as to have it corroborated. He is guided by a curiosity that cares only for what the new evidence indicates. Science recognizes that no amount of evidence is ever absolutely certain, that no knowledge is everlasting and immutable.
>
> The teacher who can give his class even an inkling of what true evidence is has made their intellectual lives safer and better. . . . If he tries to expound the abstract principle, he will accomplish nothing. He can convey understanding only by putting before the class one concrete illustration after another, and so gradually bringing out the difference between empty "thinking" and real proof. The humbler the demonstration the better.

The measure of a good experimental exercise is not easy to define. There are several criteria which can be applied all or in part. Among such criteria the following would be found:

1. Is the purpose of the experimental exercise stated clearly as a question?
2. Is the variable factor or hypothesis to be tested clearly identified?
3. Are the control factors identifiable? Are they adequately provided for?
4. Are the directions clear and concise?
5. Do the directions permit some latitude for the pupil to use his initiative and resourcefulness in planning and devising or are they "cook bookish" in nature?
6. Is the conclusion to be reached by the experimental exercise closely related by logical pattern to the stated purpose?
7. Is provision made for identifying the assumptions that are basic to the acceptance of the conclusion?

There is some evidence to indicate that teachers of ninth-grade general science present a large portion of the experimental work by the demonstration method. This is in no way a condemnation of the demonstration technique. If any criticism may be

All too often we science teachers fail to consider the total learning situation and fall into the error of spot-lighting a rather isolated demonstration or experiment. And within the experiment or demonstration itself, we neglect to take advantage of the full learning potential. "Bud" Obourn's speciality for many years has been that of trying to develop "more rounded, more fully-packed" learnings out of experimental teaching. Some of his ideas, suggestions, and techniques are described in this article.

made, it lies in the fact that most teachers fail to make any differentiation between true experiments and demonstrations. Either all work preformed at the demonstration table is "experiment" or "demonstration." The thoughtful teacher will see that an exercise used to illustrate the application of some science principle is a much different situation from one used to test hypotheses.

The evidence available at the moment would seem to indicate that many teachers of science do not seem to be aware of the general principles which apply to good experimentation. These have been well summarized by Blough:

1. Experiments should be conducted in such a way as to make pupils think.
2. Children should be conscious of the purpose for performing an experiment.
4. In so far as possible, children themselves should perform the experiments, working as individuals or groups.
5. Many times, children can suggest experiments to answer their own questions.
6. Experiments should be performed carefully and exactly.
7. Pupils should learn the value of controlled experimentation.
8. Simple apparatus is more appropriate for use in experiments in the elementary (and junior high school) than complicated material.
9. Pupils should exercise great caution in drawing conclusions from experiments.
10. As many applications to everyday life situations and problems as possible should be made from an experiment.

The role of assumptions in accepting or rejecting conclusions is perhaps one of the most neglected elements in the teaching of experimental exercises. Many of the ideas accepted as truth are based upon assumptions, implied or stated. It would seem that more attention might be given in experimental procedures to the identification and evaluation of the assumptions which are basic to the conclusions reached.

As an example, consider an experimental exercise which might be a part of any course in ninth-grade general science.

The Elements of a Fertile Soil

Purpose: Do some kinds of soil bacteria help plants to grow?

Directions: Secure two pots of soil from a field in which good crops of clover or beans are growing or have recently been growing. Heat the soil of one pot to 130° F. and keep it at that temperature for 20 minutes in order to kill the bacteria in the soil. Then plant in each pot some seeds of clover and beans. Keep both pots well watered and in good growing light and temperature. When the young plants are a month old, what difference can you determine in growth and in root conditions?

Conclusion: Some kinds of soil bacteria do aid the growth of plants.

The acceptance of this conclusion rests upon certain things that are taken for granted as true (assumptions). Among these are the following:

1. The soil in which clover or beans grow contains bacteria which aid the growth of plants.
2. Heating to 130° F. for 20 minutes kills the soil bacteria.
3. Soil bacteria are the sole cause of the differences produced in growth and root structure.
4. The seeds used in each pot had the same rate of germination.
5. Clover and bean seeds will germinate, and their plants will grow, in soil which has been heated to 130° F.
6. One month is sufficient time to determine a difference in growth and in root structure of plants in the two pots.
7. A temperature of 130° F. does not break chemical compounds in the soil into elements or other compounds which aid the growth of plants.

These assumptions would seem individually necessary and collectively sufficient to the acceptance of the stated conclusion. In teaching experimental exercises in any science subject, it is very essential that consideration be given to the identification and evaluation of the assumptions which underlie the conclusions reached.

Teachers who are interested in utilizing the maximum of potential values of the experimental exercise for promoting the growth of pupils will be observed doing some of the following things as they teach:

1. They will let the pupils propose and define problems for laboratory study.
2. They will let the pupils frame the purpose of the experiment.
3. They will let the pupils propose hypotheses.
4. They will let the pupils identify the control and variable factors in the experiment.
5. They will let the pupils plan the controls.
6. They will let the pupils make the observations.
7. They will let the pupils interpret the evidence.
8. They will let the pupils formulate the conclusions to be reached.
9. They will let the pupils state the assumptions that are basic to the acceptance of the conclusion.

Moving to—

Semimicro in High School Chemistry

By HARRY H. WILLIAMS

Instructor of Physical Science, Horace Mann School, New York City

THERE are indications that high school science teachers are eager to know more about the possibilities of the semimicro method for secondary school chemistry. It has been our experience that teachers are prone to accept invitations to "come and see the method in operation." During the past year a number of such visitations made to our chemistry laboratory for this purpose have resulted in the adoption of semimicro procedure by other schools; the general response of visiting teachers has been one of approval. Since such has been the case, we welcome the invitation of the executive secretary of NSTA to state briefly our own reactions to the method based upon our own use of it and to point out essential steps to be taken by others who would like to try it in their own laboratories.

Our introduction to semimicro techniques came 13 years ago at a conference of secondary school teachers at Yale University. There the conferees were conducted through the laboratories, including one in inorganic chemistry, set up for experimentation on a semimicro basis. After marveling at the small size of the individual equipment and especially of the general reagent bottles, the method was promptly catalogued in our thinking as further evidence of the highly specialized nature of college chemistry. There was no immediate recognition of the fact that the general method might well be looked into further and be considered for whatever use it might have at the secondary school level. Those of us who were firm believers in emphasizing the general education aspects of the high school sciences might indeed have been the least impressed had any one suggested the adoption of the semimicro method in our own chemistry classes.

In recent years we have all heard more and more of the use of small scale methods, especially from our graduates who have returned to tell us how thoroughly the colleges have turned to semimicro in their courses in qualitative analysis. Occasionally, we may have heard of a high school chemistry teacher who was experimenting with it in his classes. In my own case, I had glowing reports about it from time to time from teachers of experience who enrolled in the methods course which I give in the teaching of the physical sciences. Finally, it seemed advisable for me to give the method a trial. Several students in my secondary school chemistry classes were shifted to the semimicro method after they had done considerable experimentation in the conventional manner. The pupil response in favor of the new method was one-sided enough to lead us to consider seriously its general use in our chemistry classes. Further consideration led to the decision to try it.

Perhaps the most obvious advantage of the semimicro method is the monetary saving in subsequent years after it has been installed. No doubt this is one of the most attractive points as far as the method is concerned. Our own experience has been about the same as that of others who have reported a savings of about 30 per cent on individual desk apparatus and upwards of 40 per cent on the chemicals after the change from macro to semimicro had been made. There is, of course, an initial outlay to consider. In our case, our costs at the time of the change over were approximately double what they would have been otherwise.

In addition to very real savings in yearly cost there are savings in space. Our own laboratory, for example, was originally planned with individual storage space for 64 students. The reduction in storage space required per student makes it possible for us to use this laboratory for three classes totalling 96 students without having any two students use the same individual equipment except for ringstands and pneumatic troughs. Even with these pieces of equipment there is no duplication of use within the same class.

As great as the above savings are, there are others which many will consider to be of even greater importance. These center about the improvement of instruction. With the abundance of chemicals always readily available to the student, it becomes much easier to administer a laboratory program which takes into account individual differences. Thus each student may be allowed to pro-

Teachers of chemistry are confronted with the problem "to change or not to change" to semimicro techniques in high school. This seems to be particularly true in programs offering modified physical science courses for non-science majors and a "stepped-up" chemistry course for the more science-talented group. Dr. Williams in this article reviews some of the problems involved in making the change and offers suggested ways out, based on his own experience.

gress at his optimum rate. In general, students are able to do more experimentation within the available time when the semimicro rather than the macro method is used. Thus more time becomes available for laboratory projects and actual experimentation in addition to the traditional direction-following type of laboratory exercise. We also have found that the teacher is freer of routine work and hence able to give more individual instruction during the laboratory periods.

Another important advantage inherent in the use of smaller quantities of chemicals relates to safety and health hazards. There is less danger when a student handles several drops of concentrated sulfuric acid using a dropper system than when he handles several milliliters of the same acid pouring it from one container to another. It is interesting to observe how much more carefully students adhere to recommended quantities of materials when using small quantities than when using much larger amounts. This and their natural tendency to exercise greater care when handling small quantities tends to eliminate a good deal of the sloppiness found to varying degrees in most, if not all, elementary chemistry laboratories.

It is obvious that smaller quantities of chlorine, hydrogen sulfide, and other poisonous gases can be handled with less irritation and in greater comfort than can larger quantities. Perhaps the biggest advantage in this case accrues to the teacher, since it is the teacher who is exposed to these gases period after period when one laboratory class follows another.

Before the installation of semimicro techniques, we were confronted with a serious shortage of hood space. As other users of semimicro techniques have found out before us, it is now rarely necessary to use hood ventilation. So slight is the irritation that we now permit students to make the halogens at their regular places of work. This, of course, might not be advisable if the chemistry room were not a large room. Our two hoods which were so inadequate formerly are now more than enough.

Next let us consider the problems faced by one who decides to shift his laboratory from the macro to the semimicro method. There immediately arises the question as to whether all of the macro apparatus formerly used by students must be discarded and all new purchased. Such is not the case. Besides that portion which would be retained for demonstration use, much of the macro apparatus is usable, as is, in the new system. Some other items can be adapted to semimicro use. Certain new items are, of course, indispensable. Among the items that need not be replaced are the ring stand, rings, burette clamp, and Bunsen burner. We found it a simple matter to adapt our wire-basket type of test tube rack by simply adding to each a section of wire mesh for the shorter test tubes to rest upon. While micro burners are available, we have found the regular burners that we already had to be quite satisfactory.

Practically all new glassware of smaller size must be provided. This includes test tubes, beakers, flasks, funnel tube, wide-mouth bottles, etc. General equipment that must be purchased includes centrifuges, general reagent bottles, and trays for holding the latter. Two centrifuges have proved to be more than adequate for a class of 32. The trays can, of course, be made in the local school shop, although they are also obtainable from supply houses.

There is no need to list fully here the macro apparatus that may be retained and the new equipment whose purchase is either (a) desirable or (b) necessary. The teachers guide book[1] provided by the publisher of a semimicro laboratory manual for high school chemistry laboratory work lists in detail all such information in very usable form and suggests where various of the desired pieces of apparatus may be purchased.

However, it may help some who will consider the desirability or practicability of changing from the macro to semimicro method, if we list some of the questions that teachers have asked and then answer them in terms of our own experience.

Do all of the usual laboratory exercises lend themselves satisfactorily to the small-scale technique? It is our opinion that they do so quite satisfactorily. While we have used a commercially distributed laboratory manual designed especially for this method, others have reported that they prefer to revise their own exercise sheets and adapt them for use with the smaller scale apparatus and the

[1] Weisbruch, F. T. *A Teacher's Guide to the Introduction of the Semimicro Method in High School Chemistry.* D. C. Heath & Company. Boston. 1946.

smaller amounts of materials. One professor of chemistry long ago went so far as to write,[2] "There is nothing which at present is done by students with large apparatus that cannot be done with the micro-method, but there is much that can be done with small apparatus that is sheer waste when done on the larger scale."

How do students who have done their laboratory work by semimicro techniques and those who have used macro techniques compare in such items as knowledge of chemical facts and generalizations, and the various abilities associated with the effective use of scientific methods? Studies that the author has seen seem to indicate no difference that is educationally significant. Slight but hardly significant advantages have been reported for each method. In our own situation we have not noticed any difference in results on our own tests, standardized tests, or on those of the College Entrance Examination Board. Chemistry in our school is elective in either the junior or senior year. Each year some 15 or so of the seniors take the chemistry examinations of the College Entrance Examination Board. It is our opinion, not based upon statistical analysis, that there has been no noticeable change in the results on these or other examinations. It is our guess that those trained by the semimicro method would at least hold their own on a practical test of laboratory performance.

Shift to Micro Cuts Preparatory Time

How big a job is it to make the shift from macro to semimicro? The filling and labeling of the reagent bottles is a time-consuming task. In our laboratory there is one tray of reagent bottles for each two students. Each student, however, does individual laboratory work except for a few exercises where two are allowed to work together. For a class of 32, therefore, it was necessary to prepare 16 trays of reagents. Since there are 107 bottles in each of our trays, this meant that 1712 bottles had to be filled, properly labeled, and then given a coating of label glaze. Each bottle cap was also given a designation in white ink according to a prepared key. These markings were then made more durable by giving them a coating of shellac. The above work was done under teacher supervision in several days during the summer vacation by two students who volunteered to do it. This and the preparation of the shelves of reagents discussed under the next question constituted the major preparatory arrangements. In our case it was also necessary to have electric outlets installed at strategic points for the centrifuges.

Do students tend to contaminate the reagent bottles as they use them? There is, of course, no contamination problem with the liquids. These have caps fitted with dropping pipettes. After explaining to the students the reasons for exercising great care in removing reagents from bottles, the acceptable method for removing solids from bottles was demonstrated. With insistence that the students use this method consistently, we have had no problem of contaminated chemicals, whatsoever.

Many Reagents Last Full Year

Do student reagent bottles require frequent refilling? Occasionally reagent bottles do require refilling as is to be expected. However, it has been our experience that with a total of six students, two in each of three classes, using each tray, a large proportion of the reagent bottles within the trays are not likely to require refilling within the school year. This is, of course, excepting the general reagent bottles containing the common acids and bases which are kept in a separate location. A few of the small reagent bottles may require several refillings each year. This has been found to be true, for example, of the bottle of mossy zinc.

There seems to be no real reason why students should not refill their own reagent bottles as fast as they become empty. This is easily arranged if there is sufficient shelf space to make a stock bottle of each reagent available to the students. The added responsibility has educational value to the student, and it frees the teacher to teach. In our scheme the stock bottles of chemicals are arranged on shelves at the end of the room in exactly the same order in which these chemicals are found within the student reagent trays. The shelf position of a stock bottle is labeled to correspond exactly with the designation found on the label on the side of the student reagent bottle containing the same chemical. In this scheme the teacher needs only to supervise the general plan and attend to the replacement of the stock bottles on those infrequent occasions when they become empty.

From the foregoing it is no doubt clear that we at the Horace Mann School are more than satisfied with the change from macro to semimicro techniques in our chemistry course. If the review of our experiences helps others in their deliberations about this subject, this article will have served its purpose.

[2] Grey, E. C. *Practical Chemistry by Micro-Methods.* W. Heffer & Sons, Ltd. Cambridge, England. 1924.

Project Teaching on the College Level

Biology Students Help Rid Their City of Rats

By RUTH NEWMAN DUGAN

Dean of Women, John Marshall College, Jersey City, New Jersey

IF YOU ARE seriously contemplating use of the project method in teaching biology on the college level, I warn you that you must have fortitude enough to face keen disappointment many times; you must be ready to defend your plans, for you will be severely criticized; you must be a pioneer in teaching, for, instead of measuring facts and principles learned by students, you must evaluate individual growth—and you must expect the richest rewards of your teaching career! A paradox? No, not really—but the results of the project method are rarely middle aisle. The teacher succeeds in stimulating an enthusiasm and initiative that he never attains through the ordinary classroom methods. But when he meets with defeat (as has been my experience in some instances), believe me, it is no ordinary failure.

A good project grows and gains momentum as it goes along. Last September one of my hygiene groups selected the problem of rat control as a term project. They had ample reason for choosing this topic. As one of the students stated, "Jersey City and surrounding communities are being overrun with rats because garbage is dumped and burned in the city's swamp area. During the last administration, 50 thousand dollars were appropriated for the extermination of the rats that infest these dumps. Cyanos gas was pumped into the burrows, and thousands of rats were killed. Because of a political upheaval, this program ceased, and very little is being done at present to combat this health menace."

Just what could a group of students do to revive interest in this much-needed public action? First of all, we knew we had to learn a great deal more about rat control. The students' statements showed clearly that many teaching objectives might be realized by such a well-motivated problem:

1. Adult understanding of, and concern with, the health problems of the community in relation to housing, health services, and health education.
2. Understanding of the extent to which public health is affected by commercial enterprises that disregard health and human welfare, and a determination to put loyalty to the common good above private gain in personal life and public action.
3. The tendency and ability to keep informed through reliable sources concerning scientific developments in heatlh.
4. In maturing interpersonal relationships—intelligent concern with the removal of the cause of human conflict. Ability to perform a wide range of useful tasks with scientific understanding. Ability to use the scientific method in meeting situations. Ability to work with fellow classmates toward a common, worthwhile goal.
5. In a responsible socio-economic action—ability to participate in public forums and movements in the interest of socio-economic action. Unwillingness to enter into undertakings for private gain at a sacrifice to common good.

The boys eagerly collected data—from the federal and local government, from cities that had had successful rat control programs, from exterminators, from health inspectors and maintenance men in food plants, from periodical literature. By the end of two months, over 200 references had been carefully investigated.

During this period the boys in my biology groups also became interested in the problem. We purchased albino rats from a supply house and carried

Project teaching *can* be carried on at the college level. And *high school* biology students, too, could work to rid their city of rats. This article offers suggestions for both instructional levels. However, there are problems: Dean Dugan writes, "This experiment may be the last of its kind in our college. The State Department of Education has recommended that we administer *Intermediate Tests for College Students*. After careful study of these examinations, the faculty has decided that no longer will we be an 'open-lid' college. We must now teach traditional courses emphasizing facts and principles. This is a severe blow and certainly a detriment to our efforts to achieve modern objectives in education." And so the argument goes on. Where do you stand?

on experiments in nutrition. The day our first mature pair had a litter was an exciting one indeed! Ten offspring at one time! Five weeks later, the same female bore another litter of 11! We could easily realize why there were two rats for every person in the United States.

The students visited the city dumps as a field trip and found the burrows of the rats. A few of them organized a hunting party and brought three live rats back to school. Rather gingerly, we carried on bacteriological experiments with the rat feces.

So many ineffective rat poisons are on the market that the boys decided to test the efficiency of certain poisons. They administered increasing amounts of the poisons and finally killed off the three dump rats. One of the poisons was Red Squill—recommended by the authorities as the safest and most effective. Although its action was slower than the others tested, the students recognized that the Red Squill has an advantage over other poisons. Animals other than the rat have the power to regurgitate—Red Squill acts as an emetic, and thus only the rat keeps the Red Squill in its stomach.

Group Studies Other Cities

One group of boys investigated just what was being done in Jersey City at that time to control rats. They investigated the city health codes and found that rat control was not mentioned once in the ordinances. They wrote to other cities to find what had been done by them. Detroit and Baltimore had just completed a rather thorough rat program, and they were quite helpful in suggesting things the boys could do to begin an active campaign.

The chief health inspector of Jersey City informed us that a rat control program is mainly an educational campaign and that people must continually be reminded of the health hazard as well as the economic loss that the rat causes. Among other things, this meant posters.

I have always been interested in art as a hobby. Encouraging the boys to paint posters was easy. We all had lots of fun after classes dabbing in water colors. I can't say that the results were exactly artistic, but the boys enjoyed doing it and were very proud to see their work displayed in the neighboring store windows. They also found out from the health inspector that the public school children of Jersey City had painted over 300 posters on rat control. These posters had not been displayed. The boys secured them from the Board of Health and sold store owners throughout the various business sections of the city on the idea of setting up rat control displays in their store windows. Not exactly biology—but a lesson in human relations that they would never receive in a traditional classroom.

Newark, a nearby town, was having an active campaign to clean up its slums. One of the boys prepared an exhibit of all the articles in the Newark papers concerning this. Pictures of the slum areas where rats are prevalent suggested a new phase of the problem to the boys with photography as a hobby. They searched Jersey City for pictures of slum areas and prepared a very interesting exhibit.

English Department Cooperates

One group decided to interview local exterminators to determine methods of extermination of rats in Jersey City. Their English instructor became interested and agreed to accept the written report of their interview as a composition assignment. The letters they wrote to the various sources for information were also accepted in lieu of a more formal type composition—and, best of all, their term paper in biology was to be supervised by the English department.

By the time the semester was over, the students felt they had just begun to participate actively in the rat control program. They were sure that their letters and their visits to the city hall had been a factor stimulating the authorities to begin exterminating in the Journal Square area of Jersey City—the locale of John Marshall College.

Our plan for continued activity into the second semester required the support of other subject departments in the college. In a small college like John Marshall all faculty members are aware of what is being done in other classes. All faculty members know their students quite well. It seemed to the faculty, at one of the weekly meetings, that we had found a theme around which we could build a well-integrated program. If we could meet our general objective of preparing students to live effectively in their own environment by direct means rather than by hoping for transfer of training—all the better.

Most subject departments could contribute in some way. The speech department set up what the boys labeled an "advisory system." Lectures on rat control were prepared for various groups—Boy Scouts; school children; restaurant owners; businessmen's clubs like the Rotary, Lions, and Elks; women's clubs; and religious groups. These speeches were recorded by the boys, and speaking programs were arranged. It was not the plan of the lecturers to deliver only one speech to each group. The purpose of the advisory program was to

guide and stimulate other groups in active participation in the "war on rats." One student would be general advisor to one group. He would invite fellow students who were "experts" in specific phases of rat control to lecture. For example, the advisors to the Boy Scouts encouraged the troops to earn their citizenship badges by including some of the following activities:

1. Report backyards littered with refuse.
2. Report garbage cans without lids.
3. Report rat tracks and droppings.
4. Distribute rat control throwaways and pamphlets. (Pamphlets were mimeographed by the students.)

The advisors were leaders and guides in directing group activity.

The students improvised as they went along. One week when mothers and children lined up daily to see *Cinderella* at a nearby theater, they mimeographed throwaways—"Mothers of Jersey City—Your City is Overrun with Rats."

Students who were interested in journalism organized "inspector groups." The boys in the "inspector groups" accompanied Board of Health inspectors on rat complaint calls. They interviewed the people who had rats—storekeepers, tenants, landlords—they observed the surroundings—and they took photographs. (The film was supplied by the school.) The students felt that it would be profitable to visit the New York Health Department. They accompanied the New York inspectors on rat calls in the Harlem section. Two of the boys visited Dr. Greenberg, who discovered and classified Rickettsial Fever. He took them through his laboratory and told them the story of this new rat-borne disease. He explained his future plans for research and gave the boys reprints of his articles.

All the data was compiled by the students, and a series of articles was prepared for the local newspapers. The theme of the articles was, "How Complacent Can You Be?—Rats are Overrunning Our City—And You Continue to Feed Them!"

Law Department Drafts Ordinance

Since the health codes of Jersey City had no rat control ordinance, the law department of the college has been drafting an ordinance that might be acceptable. The students have sent for copies of rat control ordinances from cities that have been successful in the elimination of rats. When the ordinance is ready for presentation to the city government, the government classes plan to follow the bill through the required channels. It is hoped that by actually following the entire process of legislation the students will gain a practical knowledge of legal procedure.

The economics department is engaged in surveying the financial aspects of control measures. The data collected will be used as another tool of persuasion. The authorities and the public must be shown that a permanent control program, including such improvements as: (1) an incinerator garbage disposal system; (2) rat-proofing of buildings; and (3) increased personnel in the Health Department to adequately guard against re-infestation, will eventually save a great deal of money.

The work done by the students has indeed stimulated public action. The city is actively engaged in a rat control program. We have been invited to attend the meetings of the rat control committee. We have actively participated in the planning of the program for Jersey City. The Sanitation Department of the city is working hand in hand with the Health Department. During the month of May they carried on an enthusiastic clean-up program. Part of this program included a "better block barrel contest." For three garbage pick-ups, every house and every block in the city was evaluated for refuse preparation, adequate garbage containers, protection of wastes from rodents, and community pride in block cleanliness. This, of course, meant an extensive inspection schedule.

Students Serve as Judges

The John Marshall students were asked to participate in the initial judging. Six a.m. on garbage collection days the students met the sanitation inspectors and formed groups that covered every garbage barrel on every block in the city. Twenty students volunteered, and not one backed out on any of the trips—in spite of the early hour and the amount of shoe leather burned (for all transportation had to be on foot). I was asked to be among the final judges to determine the winning block, as well as the individual winners of prizes amounting to over 2000 dollars. The prizes were awarded in one of the largest theaters in the city.

Ten students accompanied me to New York University's Graduate School of Education. Here we described our project to a group of 50 biology teachers. A film, *Vandals of the Night* (on rat control and loaned to us by the Health Department), was shown to the group. If only a few of these teachers "catch our fever," we will feel rewarded.

I mentioned that this experiment in project teaching has been a very broadening experience, but that I have made many mistakes. My biggest mistake has been in evaluation. It is the most difficult part of the whole attempt. At the mid-term period I was almost ready to admit a complete fail-

ure—for I could not evaluate in terms of what I have been accustomed to measure. In the first place, at the beginning of the semester, I announced that there would be no final examination (I couldn't conceive of testing in the orthodox manner a new approach of this sort). This was a mistake. The first group was a freshman class fresh from high school where they were accustomed to assignments daily, tests monthly, and a rod! This, to them, was to be a snap course.

They were interested enough in gathering material, performing experiments, and discussing their activities in class. But it seemed to me that I must have a more concrete proof of their progress. A report of all the reading they had done in the form of a term paper was to be a rather heavy criterion of their achievement up to that time. The day the report was due I found them hurriedly scribbling their ideas on notebook paper! Except for a few, they were examples of work that would not be accepted in grammer school. My marks convinced them that this was not a snap course. But the attitude of the group changed for a while. There seemed to be less spontaneity, less community spirit, less interest.

They felt that I had not evaluated them in terms of what they had actually been doing, and they were right. They realized that they must prepare a presentable summation of their achievement for the final grade, but class participation, ability at scientific thinking, solving problems, and scientific attitude, will weigh heavily in the determination of final grades. My groups are small enough for me to know each individually; I have administered entrance examinations to all when they entered school; I have been advisor to most—I should be capable of measuring individual growth in personality development, scientific method and attitude, and in actual subject matter without formal tests or papers.

My students have proved themselves good citizens in their rat control activity. I have seen student initiative, enthusiasm, and growth that I have never seen before. The best kind of evaluation must be by personal observation—a sensitivity on the part of the teacher who learns to recognize individual growth. Even this type of evaluation has its limitations, however.

We all use ourselves as a final yardstick. The things we do with ease, others must do with ease; and those things that are difficult for us are deemed worthwhile when achieved by others. Evaluation can never become purely objective, for values are determined by human beings and not by machines. We can only try our best!

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Two Classroom Demonstrations

Biology

Mendelian Inheritance

By MICHAEL ADRAGNA, Instructor of Science Education, School of Education, New York University.

TO DEMONSTRATE the Mendelian law in human inheritance in class is often found to be quite difficult. Teachers generally resort to various forms of excellent visual materials for this purpose. However, these teaching aids lack the peculiar conviction associated with witnessing the operation of the law in oneself. In some rare instances where a class member may be used as an example, the teacher is confronted with the delicate considerations of adolescent psychology and hence usually discards the idea. For these reasons it has been found advisable to seek a phenotypic trait that students consider unimportant and that, at the same time, can be easily demonstrated in class. One such trait is found in the physiological sense of taste,

It has been known for some time that persons vary in their ability to detect the bitter taste of a white granular chemical, phenylthio carbamide;[1] some can taste it while others cannot. Furthermore, this difference has been traced to a single pair of genes that follow the Mendelian law of dominance. Accordingly, it has been shown by various investigations that about three-fourths of the American population can taste phenylthio carbamide and one-fourth cannot. Thus, the tasters must be pure homozygous or hybrid heterozygous, while the non-tasters must all be pure recessives.

In class, the procedure has been to dissolve about one gram of phenylthio carbamide in about 20 ml. of water and pass it around with a box of toothpicks. Each student was asked to dip a toothpick into the solution and to taste it.[2] The results have conformed closely with the established ratio.

Additional genetic data on the tasters or non-tasters can be readily obtained by giving each student a sample amount of the solution and requesting him to test the remaining members of his family. Their reports will prove interesting, not only to them, but also to the rest of the class who can attempt to determine the probable genotypic constitutions with regard to the one factor under investigation.

[1] Scientific supply companies also sell it under the name of thiophenyl carbamide.

[2] Candy was passed around in order that students who experienced a bitterness might neutralize the unpleasant effects.

Chemistry

Fast Red

By CHARLES H. STONE, Orlando, Florida, and GEORGE W. ANDERSON, High School, Orlando.

THE PREPARATION of Fast Red involves diazotization and coupling, neither of which is likely to be well understood by a student of first-year chemistry. The actual procedures are so simple and easily carried out that anyone can make this dye in a few minutes.

Directions: Dissolve five grams of sodium naphthionate in water. Add three grams of sodium nitrite and stir until dissolved. Acidify with HCl. The result is solution A.

Dissolve five grams of powdered beta naphthol in dilute sodium hydroxide solution, forming solution B.

Pour solution A into solution B. Stir and keep cold.

Wet a small skein of white wool yarn with water and immerse it in some of the dye solution. Heat to boiling. Remove; rinse under running water; squeeze; and dry between blotters of filter papers.

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A Tin Can Planetarium

By FLETCHER G. WATSON
Associate Professor, Graduate School of Education, Harvard University

A "TIN CAN" planetarium, a simple device for projecting star images, can be made by following the instructions below. With this device children can learn, under a teacher's supervision, to identify the brighter stars and the more obvious constellation groups. With such a start and a star map they can, at home or elsewhere, go on to learn the other constellations, if they desire.

This "planetarium" shows only about 125 of the brighter stars. Stars fainter than the third magnitude are not shown, except when necessary to complete a few conspicuous patterns, because street lights obliterate fainter stars for most city dwellers. Even where faint stars can be seen, first familiarity with the heavens should be limited to a few bright and conspicuous groups.

The finished instrument consists merely of a flashlight bulb shining at the center of a surrounding can. Through small holes in the can the light of this bulb goes out to strike the walls of the surrounding room and to form on the walls small images of the bulb's filament resembling stars. The lamp filament should be as small as possible, and the holes should also be small and properly located.

Just as the positions of all places on the earth are recorded in latitude and longitude, the positions of all heavenly bodies are determined in a similar set of coordinates. One coordinate, similar to latitude and known as "declination," is measured both northward and southward from the celestial equator towards the poles. The other coordinate, similar to longitude and known as "right ascension," is measured only eastward from an arbitrary point (the Vernal Equinox). To plot the stars on the can we need to lay out on it a coordinate system, north-south and east-west, equivalent to the coordinate system used on a spherical sky.

Once the positions of the stars have been plotted, small holes can be punched in the can with a conical punch, like a phonograph needle. Bright stars are represented by relatively large holes and faint stars by very small holes.

The appetite of many science students for suitable "projects to build" seems almost insatiable. The need of many science teachers for demonstration apparatus is urgent. Here is a piece of equipment that meets both purposes. Patience, a modest amount of skill, and the simplest of materials—a tin can, a phonograph needle, some cardboard, wood, some finishing nails—are all that are needed for constructing a teaching and learning tool that will serve your school for years to come.

Fletcher Watson reports that several planetaria of this sort have been made by his friends who are elementary school teachers and that they report pupil response to the actual presentation and manipulation of the apparent places of the stars to be very, very high.

"Frankly," says Watson, "I consider material of this sort would do more for the teaching of astronomy—to make it real and sensible—than will the preparation of many more books on the subject."

Procedure

Select a clean can of size number 2 or larger, up to one gallon. Give the outside and top a coating of thin white or cream paint. This will provide a base on which to draw the coordinate grid used when plotting the star positions. Give the inside of the can a coating of dull black paint; this is to eliminate internal reflections which produce multiple images of the stars.

Determine the diameter and height of the can and carefully draw on a sheet of paper the outline of a central cross-section as in figure 1. Draw the central axis of the can; the "north pole" is to be where this central axis goes through the top of the can. Along the central axis measure down from the top a distance of three-fourths of the can's diameter (this distance is not critical, but should not exceed one full diameter). This point on the central axis is the "center of projection"; in the finished model this is the point to be occupied by the filament of the bulb.

Through the center of projection draw a horizontal line which marks the "equator." Around the center of projection draw a circle, having the same radius as the can, to represent the celestial sphere. With a protractor mark off along this circle ten-degree intervals, both north and south from the equator. With a straight-edge draw lines from the center of projection through each of the ten-degree

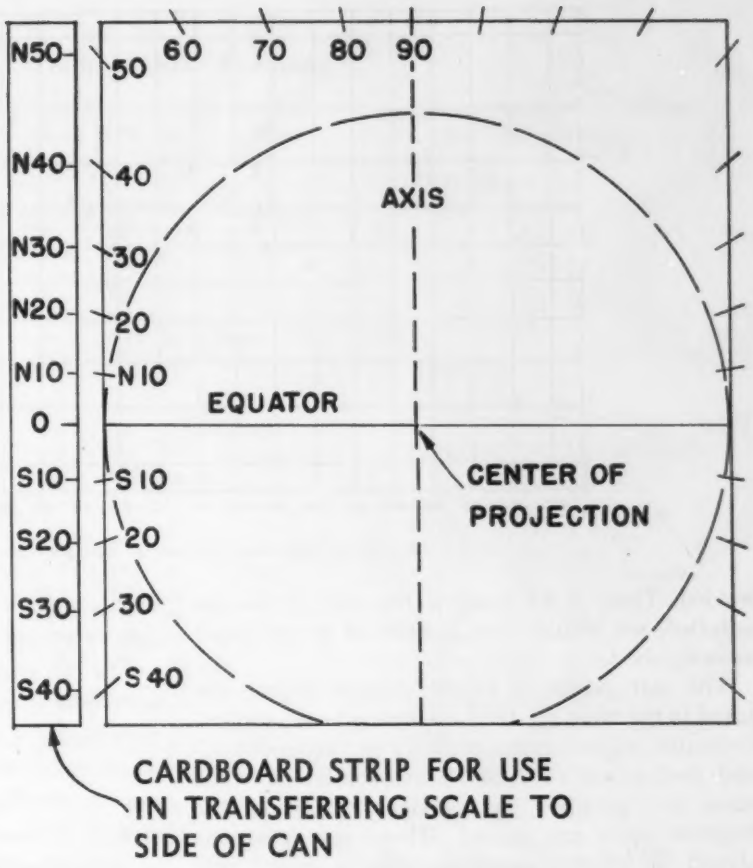

FIGURE 1. How to establish the north-south scale

points until the lines cut the outline of the can. Label northward the points along the can outline from 0° from the equator, 10°, 20° . . . up to the central axis which is 90°—the north pole. From the equator, also number down as far as you can go; this should be to 40° or 50° south. The north-south, or declination, scale is now established and is ready to be transferred to the can. This is readily done by copying the scale on a strip of cardboard which may be held against the can for marking. A similar strip may be used to transfer the north-south scale to the top of the can where circles are drawn as in figure 2. Incidentally, the north-south scale on the side of the can is a "cylindrical projection" which resembles but differs from a Mercator projection used for many maps.

The "around" or right ascension scale is more easily made. Trace around the can, as in figure 2, and locate the center of this circle. Draw one diameter; from it mark off with a protractor each 10° interval up to 360°. This around-scale for the top of the can may be cut out with scissors and laid over the actual can so the ten-degree marks can be transferred to the rim. With a straight-edge draw the diameters across the can until the top is a "pie" of 36 pieces each 10° wide. When looking down on the top, label the ends of these radii from 0° to 360° proceeding *counterclockwise*. From these points on the top rim draw straight, equidistant lines down the sides of the can to the bottom, parallel to the seam on which the can was

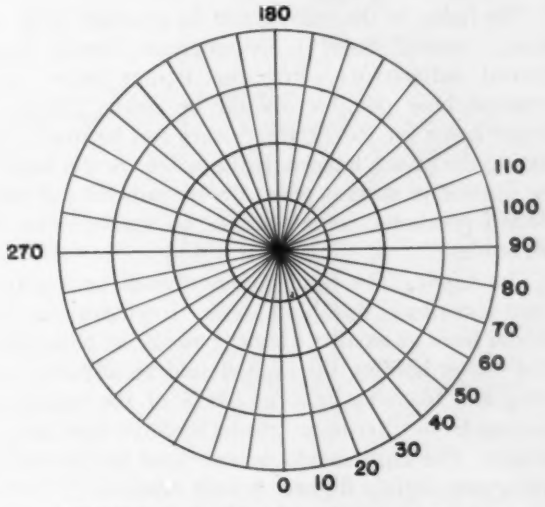

FIGURE 2. Coordinate grid on top of can

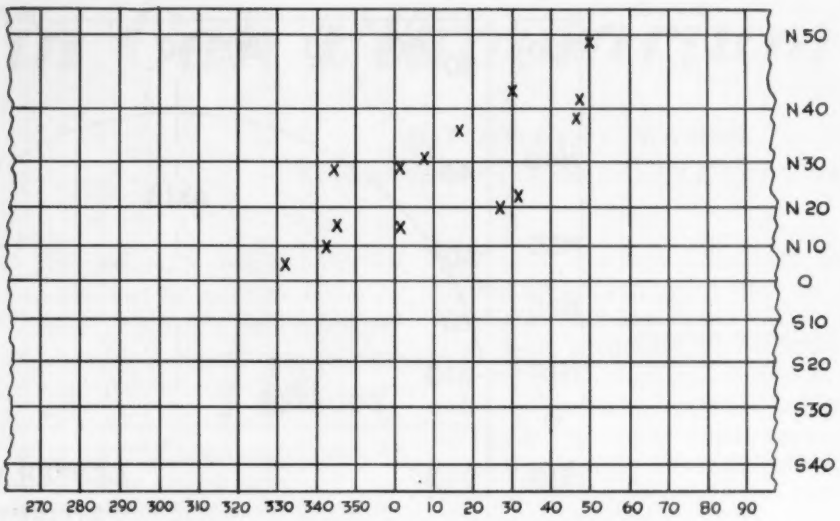

FIGURE 3. Side view of can, as though flattened out

welded. Then, if we imagine the side of the can unrolled, we would have a sheet of graph paper as in figure 3.

The star positions to the nearest degree are listed in the table (p. 183) according to the two coordinates: right ascension (RA) or "aroundness," and declination (D) or "north-southness." The stars are grouped by constellations, and the brighter stars are named. These star positions should be plotted carefully with a pencil and checked before any holes are punched in the can. Remember, right ascension is measured *counter-clockwise*. In the table the brightness of the stars is indicated by B (bright) for those of magnitude zero or one, M (medium) for those of second magnitude, and F (faint) or FF (very faint) for those of third or fourth magnitude.

The holes in the can should be punched with a sharp, conical tool; a phonograph needle has proved satisfactory. For the fainter stars the smallest hole possible should be made. Slightly larger holes for the brighter stars can be made by hitting the punch harder. If the holes are too large, the illusion of stars is poor. Before punching at the plotted positions, some practice on another can is advisable.

The Light: The light source should be a plain (non-focusing) flashlight bulb. Furthermore, it should have as small a filament as can be obtained. The socket holding the bulb should be adjusted to bring the filament into the plane of the equator. Sockets from Christmas-tree lights have been satisfactory. The bulb should be operated on its rated voltage or slightly higher. A bulb rated at 2.5 volts operated on two "standard" flashlight batteries works well. Two small angle-irons form a satisfactory spring holder for the batteries.

The Mounting: The mounting should have a wide base to prevent tipping over. Two up-rights, as in figure 4, support on two screws the platform which holds the light socket and the base of the can. A few long finishing-nails in this platform around the can will support it and still allow it to be rotated—clockwise—by hand. The platform, mounted in this manner, can be tipped to present the stars as seen from the north pole (vertical) to latitudes down to around 40° N.

The position of the sun among the stars on a given date and its annual eastward motion among the stars, as well as the seasonal effect (north to south to north), can be represented by a flashlight held over the can and properly pointed. Individual ingenuity will probably suggest additional celestial phenomena that can be represented.

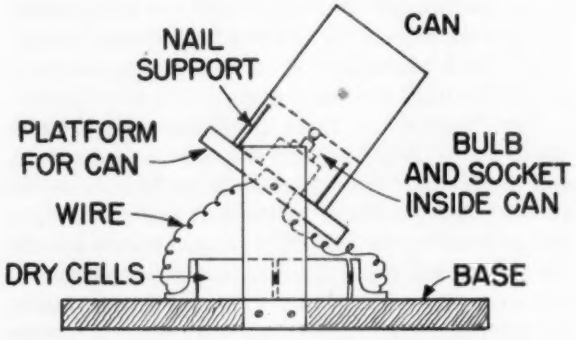

FIGURE 4. Side view of supporting frame

Table of Star Positions

Dec.	R.A.	Br.	Name
Ursa Minor			
N89°	020°	m	Polaris
N72	230	f	
N75	222½	m	
Ursa Major			
N62	165	m	> Pointers
N57	164	m	
N54	177	m	
N57½	182½	f	
N56	192½	m	
N55	200	m	
N50	204	m	
Cassiopeia			
N59	001	m	
N56	009	m	
N60	014	m	
N60	020	f	
N63	027½	f	
Andromeda			
N29	001	m	
N30	009	f	
N35	017	m	
N42	030	m	
Aries			
N23	031	m	
N20	027½	f	
Cetus			
S19	010	m	
Perseus			
N49	050	m	
N41	046	m	Algol
N39	045	f	
Taurus			
N24	055½	ff	Pleiades
N16	068½	b	Aldebaren
N15	064	f	
N18	065	f	Hyades
N19	066	f	
N28	080	m	
N21	083½	f	
Auriga			
N46	078	b	Capella
N45	088½	m	
N38	088½	f	
N33	073½	f	
N41	075	f	

Dec.	R.A.	Br.	Name
Orion			
N7½°	088°	b	Betelgeuse
N6	080	m	
N10	082½	f	
Zero	082	m	
S1	083	m	
S2	084	m	
S9	077½	b	Rigel
S10	086	m	
Gemini			
N32	113	b	Castor
N28	115	b	Pollux
N17	098½	m	
N22½	095	f	
Canis Major			
S17	100½	b	Sirius
S18	094½	m	
S26	107	m	
S29	104	m	
S29	110	m	
Canis Minor			
N5	114	b	Procyon
N9	110½	f	
Hydra			
S9	141	m	
Leo			
N12	151	b	Regulus
N17	150½	f	
N20	154	m	
N24	153	f	
N24	145	f	
N21	167½	m	
N16	167	f	
N15	176	m	Denebola
Virgo			
S11	200	b	Spica
Bootes			
N20	213	b	Arcturus
N27½	220½	m	
N34	228	f	
N41	225	f	
N39	217½	f	
N30½	217½	f	
Corona Borealis			
N31½	232½	f	
N29	228½	f	
N27	233	m	
N27	235	f	
N27½	239	f	

Dec.	R.A.	Br.	Name
Hercules			
N39°	250°	f	
N31	249½	f	
N21	247½	f	
N37	258	f	
N31	254½	ff	
N25	258	f	
Ophiuchus			
N12	263	m	
Scorpio			
S20	240	m	
S22½	239	m	
S26	239	f	
S25	244	m	
S26	246	b	Antares
S28	248	f	
S34	251	m	
S38	251½	f	
S42	252½	f	
S43	257	f	
S43	263	m	
S40	265½	f	
S39	264½	m	
S37	262½	m	
Lyra			
N39	279	b	Vega
N38	280½	ff	
N37	283	ff	
N33	282½	f	
N32	284	f	
Cygnus			
N45	310	b	Deneb
N40	305	m	
N45	295½	f	
N35	298½	ff	
N28	292½	f	
N34	310½	m	
Aquila			
N10	295½	f	
N9	297	b	Altair
N7	298	f	
Pegasus			
N10	325	m	
N6	332	f	
N10	342	f	
N15	345	m	
N28	345	m	
N15	002	m	
S30	344	b	Fomalhaut

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Puerto Rico: University of Puerto Rico

Latin America: UNESCO Tour

Travel in Outer Space

By ERNEST G. REUNING
Astronomer of the U. S. Naval Observatory, Washington

INTRODUCTION—We have with us this evening Mr. Ernest G. Reuning of the U. S. Naval Observatory in Washington, who will discuss with us the possibilities of travel in space beyond the earth's atmosphere. Mr. Reuning.

A. Thank you. Before we begin, I'd like to emphasize that my views and comments are my private ones and do not necessarily represent the views of the Observatory or of the Navy Department. I'm very anxious to have that understood.

Q. Mr. Reuning, you feel that our technology has reached a point where we can seriously consider space travel?

A. Yes, I do. It would take an heroic effort of research and development to build a space vehicle that could overcome the force of gravity; however, there aren't any new basic principles that have to be found first.

Rocket travel through interplanetary space is an intriguing idea. But is it possible? Why, of course it is—millions of Americans have recently taken such a trip via the movie, *Destination Moon*. But just in case *your* students still have questions about such an adventure, here is a helpful article by an expert in the business. The talk, of which this is a reprint, was delivered on July 12, 1950, during the General Electric SCIENCE FORUM program—a weekly broadcast on Wednesdays from Schenectady, New York, over WGY (810 Kc.) at 7:30 p.m. Illustrations are by Robert Pilgrim, Silver Spring, Maryland.

Q. Would you say, then, that we could reach the moon or another planet by just building a super V-2 rocket?

A. Definitely not. It's not that simple. We may as well mention at this point the big, fundamental difficulty that's stopped us so far. The rocket engineers call it the mass-ratio, and it stands for the ratio of the weight of the rocket filled with fuel to the weight of the empty rocket.

Q. In other words, it relates the weight of the rocket before the start to its weight after all the fuel has been burned?

A. That's right. It means that if we could take along enough fuel to reach the so-called escape-velocity, the rocket itself would have to be so light and flimsy it couldn't withstand the trip through the atmosphere. If we did make the rocket solid and strong enough we couldn't put enough fuel in it to get up enough speed to escape from the earth. Our known fuels are just too bulky for the power they produce.

Q. Couldn't we develop some new super-fuel that would pack more power per pound so a rocket could hold enough to get it away from the earth?

A. No, there's a theoretical limit to the jet-velocities you can get with liquid fuels. A combination of liquid hydrogen and liquid ozone would be best, but that's a dangerous combination and hard to handle.

Q. How about the liquid oxygen-alcohol combination that V-2 uses?

A. Well, in order to reach the necessary 25,000 m.p.h., 99.5 per cent of the weight of the rocket before take-off would have to be fuel. It means the starting weight would be 200 times the empty weight after all the fuel was used up. It would be like building a car with a gas-tank big enough and strong enough to hold 400 tons of gasoline, if the car itself weighed only two tons.

Q. That makes things look rather hopeless. Isn't there some other way out?

A. There is, in the form of a multiple-step rocket. The idea has already been tried when they fastened an American-designed WAC Corporal rocket to the nose of a V-2. The V-2 carried the combination up to its own ceiling, then the useless and empty shell of the V-2 was automatically separated from the smaller rocket and dropped back to earth. At that exact instant the rocket motor of the WAC Corporal took over and carried it to a record height of 250 miles.

Landing on the moon could be accomplished by turning the ship around and using the jet blast to slow the fall.

Q. That means, of course, that the speed of the smaller rocket was added to the speed the V-2 had already given to the combination, doesn't it?

A. That's right. So you see that if we use enough such steps we'll end up with the magic 25,000 m.p.h. needed to go into outer space. The old bugaboo of the mass-ratio will still plague us, but we distribute the total mass-ratio needed over the different stages. In a simple three-stage design I've seen, it still takes a 50-ton rocket to carry a 20-lb. payload to the moon.

Q. Would that mean it would take a 100-ton rocket to bring that same payload back to earth?

A. No, although that would seem right. Actually you have to look at it this way: We'll agree for the moment that you'd have to apply the brakes somehow after you'd gotten away from the moon and were heading back to earth. If you didn't slow down your space ship in some way, you'd hit at 25,000 m.p.h. if there were no atmosphere. But since there is one, you'd probably end up as a beautiful meteorite because of friction with the air. So you turn your ship tail end first and use the rocket blast to slow your descent. All of which means that you have to use just about as much energy for the return trip as for going. With the multiple step arrangement the return portion will therefore have to be the payload of the entire starting combination.

Q. Let's see now. We'd have a six-step rocket in our example where the 50-ton job would be the payload of the combination starting out from earth.

A. Correct. So if we maintain the ratio of starting weight to payload of our example, namely 5000 to 1, we get 250,000 tons. That's what it would take to carry 20 pounds of instruments or, let's say, white rats to the moon and back. At least with our present fuels.

Q. Which leaves us right where we started from—on earth.

A. Just about. But we won't give up that easily. Atomic energy is the obvious future answer, although we don't have a very clear idea about how to use it.

Q. Would you just put an atomic pile to work in the tail-end of the ship?

A. No, as far as we can guess now, the only way nuclear energy will be used in rocket propulsion will be to heat up and vaporize some other fluid, maybe even water, and have this so-called working fluid turn into jet gases. Even then it'll be a job to control the release of nuclear energy in such a motor. The big drawback of pure atomic energy is that a much larger proportion of the energy liberated is in the form of heat than is the case with chemical fuels.

Q. So in this hypothetical atomic motor you'd get so much heat with any sufficient rocket thrust that the motor couldn't be cooled fast enough to keep it from melting and vaporizing.

A. That's right. The cooling problem is bad enough with chemical fuels.

Q. It seems to me that the problem of shielding the crew from dangerous radiation would mean a lot of extra weight. Then there would be the danger of contaminating the starting place with the radioactive blast.

A. Yes, they'd probably always use chemical fuels for the first few miles up. You might add the interesting question of the transmutation of elements in the motor, where some special heat and strain resisting metals might turn into some stuff soft as putty.

Q. How about the ion-rocket that's such a favorite with science-fiction writers?

A. Oh, you mean the gadget where charged particles from an atomic source are accelerated in an electrostatic field to get a sort of electric jet? You might also call it an oversized television tube with no screen to stop the particles. It's been thought of, but it wouldn't give enough acceleration for the main job of overcoming the tremendous gravity of a planet. Out in the weaker fields of space it would be fine.

Q. Let's assume for the moment that we've got a workable, if wasteful, rocket engine. What would a trip to the moon be like?

A. Well, at the very start the passengers would be quite uncomfortable. The acceleration for the first few minutes would have to be several times that of gravity. At four g., for example, a 180-pound man would feel like 720 pounds, and his bones and muscles would certainly ache. Then, after the jets are turned off, there would suddenly be no gravity at all, and the passengers would weigh nothing.

Q. So there'd be no up and down in the cabin, and everybody would be floating around unless they had magnetic shoes to hold them to the floor or walls.

A. Right. Even walking on the ceiling would be a cinch, but if you moved too fast you'd sail clear across the cabin and land with a thud. The biggest problem would be liquid foods. Your milk, for example, could float in from the kitchen as a sphere, but you'd have to gobble the whole sphere in one big slurp or else it might break up into hundreds of little globules floating in all directions through the cabin.

The biggest problem would be liquid foods. Milk would float in from the kitchen as a sphere.

Q. Wouldn't the view from the space-ship compensate the passengers for all their troubles?

A. It certainly would. I venture to say the first human beings to see old Mother Earth floating out in space as a huge, multicolored sphere would have a hard time to find words to describe their feelings. I, for one, would risk my neck any time for this, and for the privilege of being among the first to see the craters and mountain ranges of the moon closer than I've seen them in the telescope.

Q. Isn't it true that the stars and the sun would be visible at the same time in a pitch-black sky?

A. Yes, they would be, and far more brilliantly than on the clearest night on earth.

Q. What about the terrific cold of outer space, and the dangerous radiations that may exist out there?

A. It should be possible to use the sun's rays by making the ship into an oversized thermos bottle that would admit heat on one side and not re-radiate it on the other. As for the radiations, we'll have to get more information from high-altitude sounding rockets, although the evidence is strong that cosmic rays, for example, don't increase in strength above altitudes already reached by V-2's. I'll hazard the guess that shielding against the sun's ultraviolet rays should be possible.

Q. I suppose landing on the moon could be done by turning the ship around and using the jet blast to slow the fall?

A. Yes, but note that again you would have to use energy to make that landing. And that brings us to the problem that interests me most: navigation out in space.

Q. But isn't it generally assumed that the first trips will be in the form of orbits computed ahead of time? As I understand it, the ship starts out from a certain point on the earth at a predetermined time and speed. That way it'll meet the moon at a predetermined point in the moon's path around the earth. Then it will describe an orbit

around the moon according to gravitational laws and return to earth the same way.

A. Yes, that's what they're always talking about. But I don't think it would work. Let's assume we know the distance to the moon and its mass very accurately. The speed of the rocket at the end of the initial combustion period would have to be around 25,000 miles per hour, and this speed would have to be accurate to within inches per second if the free flight orbit after that is to be accurate enough. The rocket would have to be at just the right place in space at the end of burning, too.

Q. You mean that if these conditions weren't fulfilled the rocket would either crack up on the moon or miss it altogether?

A. Right. So if the rocket were unmanned, you'd have to have fantastically accurate radio control, or if manned, there would have to be provision for control by the crew. Any control or change in speed or direction would involve the re-computation of the orbit.

Q. So you'd have to have a super mechanical brain along to do that job. One of those electronic computers that takes up a whole room.

A. Yes, you see, the process involved is called numerical integration, which means a step-by-step building up of an orbit. With all the bodies in the solar system constantly changing positions and all influencing the path of the rocket, any correction would have to be figured out practically instantaneously and applied just as fast because of the tremendous speed of the rocket.

Q. But we do know the mathematics of all this.

A. Yes, we do, but we haven't got a mechanical brain yet that can pick up and solve a new problem without extensive preparation. As for human computers, a friend of mine spent months taking the tiny planet "Icarus" through its close approach to the sun by numerical integration.

Q. You certainly wouldn't carry a mechanical brain in the cramped quarters of a space ship. I guess that means continuous communication with a control station on earth.

A. Either that or else a tremendous quantity of reserve energy on board to correct mistakes in judgment or steering if you had the time. You see, there's nothing to give you traction or friction for braking in space. Unless you spend energy you can't change direction, speed, or rotation. It's like sliding on ice, only worse, because on ice you do have the flat surface and gravity to hold you against it.

Q. How would you actually navigate?

Even walking on the ceiling would be a cinch.

A. By bearings from the sun and planets and a dead-reckoning distance that wouldn't be a straight line as on the oceans here on earth, but a complicated orbit in space-time. You might use radar close to a planet, but anywhere else your own position would change too much in the minutes it would take the signal to travel to a planet and back to you. Over millions of miles the signal of a portable radar unit probably wouldn't be strong enough, anyway.

Q. You mentioned something about distances to various objects.

A. Yes, the distance to the moon is known only to the tens of miles, and that to Mars only to the nearest 100,000 miles, so a free flight orbit couldn't really be computed.

Q. Well, to summarize, all this gives a gloomy picture of the possibilities of space travel.

A. In a way it does, but I'm really more optimistic. I've merely tried to point out some of the difficulties to be met. I'm sure they will be overcome, and that fairly soon. As I said before, at this point we could establish an artificial satellite for the earth by a smaller effort than it took to develop the atomic bomb. What is more important is that the United States had better be the first to accomplish this feat.

Science in UNESCO

By **BLANCHE BOBBITT**

Supervisor of Science and Mathematics, Health Coordination, Los Angeles City Schools

WHAT do you know about UNESCO? What do science teachers know about the "S" in UNESCO? It will be our purpose from time to time to acquaint you with UNESCO activities and particularly with those having to do with science.

For this first article, suppose we refresh our minds regarding the origin of the United Nations Educational, Scientific and Cultural Organization, so that we start together with a similar understanding of background.

Did you know that UNESCO was organized before the United Nations? Soon after the beginning of World War II, officials from the refugee governments began planning the educational rehabilitation of their countries. A group of these officials held meetings known as the Conference of Allied Ministers of Education (CAME). Beginning in 1943 the United States participated in meetings of this conference in London by having an official observer present. In 1944 the joint efforts of an United States delegation and the United States Department of State resulted in the preparation of a first draft as the basis of a plan for the establishment of the international organization. At the November, 1945, London conference the organization was formally established. During this conference the United States and several other delegations proposed that the word "scientific" be included in the organization's title. This proposal was accepted, and UNESCO was born. The London conference is usually called the Founding or Constituent Conference of UNESCO. The United States became an official member of UNESCO July 30, 1946, when President Truman signed the authorization measure which had been approved by Congress.

At the Founding Conference of UNESCO, in order to assure national cooperative machinery in each member state, provision was made in Article 7 of the constitution for national commissions broadly representative of the government, and of educational, scientific, and cultural bodies to be set up by member states in accordance with their particular needs. The measure which authorized United States membership in UNESCO (Public Law 565, July 30, 1946) also provided for a United States National Commission. Hence the origin of our National Commission not to exceed 100 representatives, 60 of whom are from the principal national voluntary organizations which are interested in educational, scientific, and cultural matters, 25 from federal, state, and local governments, and 15 members at large. The National Commission advises the U. S. delegations which are the official United States representatives at UNESCO conferences. The increasing recognition given to national commissions for their role in UNESCO affairs bodes well for the hope that UNESCO must involve the peoples of member states as directly as possible in its work.

In preparation for the first session of the General Conference of UNESCO, a preparatory commission representing 41 countries was appointed. This commission obtained from member states, organizations, and individuals, ideas and proposals which were submitted later to the program commission as a guide in formulating UNESCO's program.

The first session of the General Conference of UNESCO was held in Paris, November 19–December 10, 1946. UNESCO was formally constituted as one of the United Nations specialized agencies, an administrative structure was organized, a budget of six million dollars authorized, and a program adopted. UNESCO headquarters

"Science in UNESCO" is the first of several articles on that United Nations organization and on science in other lands to be carried in the journal during the year. Dr. Bobbitt, who is chairman of the NSTA Committee on International Relations, has been active in the work of UNESCO, and her pamphlet on *The "S" in* UNESCO is being widely used to supplement general science teaching.

The UNESCO *Story*, a resource booklet prepared by the U. S. National Commission for UNESCO, is now available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, for 55 cents. The 112-page booklet tells of the UNESCO program abroad and in this country and points out how all citizens and groups can contribute to "better understanding among the peoples of the world."

The Science Teacher invites teachers to contribute 200–300-word accounts of what is being done to promote world mindedness and world understanding through their own science teaching.

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were established in Paris. Dr. Julian Huxley, eminent British zoologist, was elected the first director general, and he accepted to serve for a period of two years. The program commission found that the ideas and proposals gathered by the preparatory commission were so numerous that it was necessary to establish certain criteria of selection so that a reasoned program could be adopted by the first session of the General Conference.

The basis of selection of major projects was whether the proposed activity contributed "to peace and security by promoting collaboration among the nations through education, science, and culture." The concept of peace was not "a mere absence of war but a condition of mutual confidence, harmony of purpose, and coordination of activities in which free men and women can live a satisfactory life." The position was taken that UNESCO should "not only act as an operating agency, undertaking projects on its own account," but also "as a stimulating agency, inspiring and supporting the activities of other organizations, and as a service agency, providing necessary services to the member states."

The program commission decided upon five criteria for the selection of proposals. These criteria had to do with the purpose of the organization, the coherence of the program, its financial feasibility, its feasibility in terms of staff, and the appropriateness of any given project to the end in view. The work of the program commission was then assigned to six subcommissions who were instructed to observe the criteria established, further, to limit the number of projects and to select only those projects which involved, "at least in the first year, crucially important and obviously useful undertakings." The six subcommisions were: education; mass communication; libraries and museums; natural sciences; social sciences, philosophy, and humanistic studies; and creative arts. From the reports of these subcommissions, a single, coherent program was drafted.

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Books in Review

Science for Better Living. Paul F. Brandwein, Leland G. Hollingworth, Alfred D. Beck, Anna E. Burgess. 643 pp. $3.28. Harcourt, Brace and Company. New York. 1950.

This is a textbook in general science and, according to the publishers, is usable in either the eighth or ninth grade.

The book is well illustrated; there are some excellent pictures showing time-space relationships in the field of astronomy. Experiments are incorporated as a part of the unit; i.e., not as separate exercises. At the end of each chapter there are additional experiments for those who are able and willing to explore and experiment farther. The new terms used in each chapter are reviewed at the end of the chapter in an interesting and unique way. Brief self-tests also sum up the chapters' pertinent points.

The organization of the subject is unusual for a general science text. The first unit begins with the study of man and his origin, from a biological standpoint. Following this unit is one on "Exploring the Earth." The other six units follow in very logical order. They include weather, chemistry, biology, physics, communication, and health.

Two other units deserve special mention. The first is a unit on the atom and atomic fission. This unit contains many illustrations, both drawn and verbal, which give simple explanations of atomic behavior. The second unit is on increasing biological productivity and conservation of our natural resources.

There are four chapters of the text that present subject matter in the form of hobbies. Hobbies and projects have been used much in the past in arousing interest in many fields, but this is the first time this reviewer has seen subject matter incorporated in a hobby in just this style.

Book lists follow many chapters, especially those for the hobbies of astronomy, living things, chemistry, and photography. These book lists are more than just bibliographies; they include a few sentences about each book, giving information as to its contents.

HOWARD E. NELSON
Glasgow High School
Glasgow, Montana

Exploring Our National Parks and Monuments. Devereux Butcher. 224 pp. $2.00 (paper bound); $3.50 (cloth bound). Houghton Mifflin Company. Boston. 1949.

Devereux Butcher is executive secretary of the National Parks Association and is well known for his photographs and his many articles on national parks. This book, written officially for the National Parks Association, is the most up-to-date and authoritative guide to our national parks and monuments. It is much more than a guide. It is a book for nature lovers, for schools and universities, for legislators, and for all who love our American heritage of scenic wonders, animals, birds, and plants. It is full of information on how to reach each park and monument by rail, bus, or automobile; a guide to accomodations of all kinds. Finally it tells how everyone can preserve America's great outdoors from mutilation, destruction, and commercial invasion. The book is a magnificent collection of photographs of the scenery and wildlife in our national parks. There is an excellent list of books included for further reading.

GRETA OPPE
Ball High School
Galveston, Texas

Teaching Biology for Appreciation. Alfred E. Nixon. 143 pp. $3.00. Chapman and Grimes. Boston. 1950.

The problem of the proper appeal to the student who is not initially interested in biology is attacked by Dr. Nixon in this readable little book which is crammed with "techniques and materials for teaching biology contributing toward its appreciation and correlation with art, literature, and social studies."

The author devotes three chapters to the presentation of specific techniques for interesting students in the study of biology by drawing on preexisting interests in the field of art, literature, and social studies. It is believed that by relating biology to these preexisting interests, biology becomes a significant part of the student's life, rather than an unrelated subject.

The treatment of the correlation of biology with art it the best developed section. Included are 16 plates illustrating the use of various techniques and materials in the construction of biological models and three-dimensional charts. The busy teacher seeking source material and inspiration for the stimulation of creative effort on the part of biology students will find these pages extremely helpful.

Many examples of poetry, including some student written poems, with biological materials as their subjects are included in the section dealing with the correlation of biology and literature. The use of poetry to emphasize facts of biology is urged, as is the writing of poetry by biology students.

In the field of correlating biology with the social studies Dr. Nixon emphasizes the fields of race prejudices, communicable disease prevention, and nutrition as problems requiring close interrelation of biology and social studies. Detailed outlines for units of study in each of these three fields are presented, including specific topics and suggested class procedures. In his preface Dr. Nixon states he is attempting to "free biology teaching from its 'Ivory

Lab'." Whether or not this freedom will be accomplished, of course, depends upon thousands who teach biology, but here are many practical, workable ideas for making biology a more integral and significant part of a student's life.

RICHARD H. LAPE
Amherst Central High School
Snyder, New York

A Text-Book of Inorganic Chemistry. J. R. Partington. 996 pp. $3.75. The Macmillan Company. New York. 1950.

For nearly 30 years an outstanding text and reference book of inorganic chemistry, the present edition, the sixth, has been rewritten and reset making it essentially a new book. However, the traditions of earlier editions have been continued, and Partington will continue to be one of the most helpful "storehouses of chemical information," for teachers, for college students, and for the more advanced and inquiring high school students.

No units, no problems to solve, no questions or exercises to work out, the book is organized on an informational pattern and thus provides easy access to the subject matter needed for the occasion. In this edition the very elementary topics have been eliminated or condensed to make way for much new material, including modern theories of valence and the structure of molecules. The chapter on the structure of the atom carries through americium and curium. Retained, however, are extensive discussions of history, occurence, preparation, properties, and reactions of the elements and hundreds of their compounds, usually in minute detail; for example, Partington points out (page 165) that "hydrogen is made in California by the thermal decomposition of hydrocarbons, especially methane."

The book does not contain an appendix, but its potential usefulness is indicated by a 30-page index.

ROBERT H. CARLETON
National Science Teachers Association

TRUE FAITH AND ALLEGIANCE. . . . An Inquiry Into Education for Brotherhood and Understanding . . . is a book we want to do more than merely "announce." We want to urge every teacher, every *real* teacher, to read it. Begin it, and you won't lay it down until you're read the last of its 99 pages; and then you'll be sorry you haven't a dozen extra copies to give to your friends. It was written by Dean Harold Benjamin, College of Education, University of Maryland. It was published by the NEA Commission for the Defense of Democracy through Education. Its price is 75 cents a copy.

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Exploring Our Prehistoric Indian Ruins. Devereux Butcher. 64 pp. $1.00. National Parks Association. Washington. 1950.

This interesting book begins with a delightful Indian story of "The Last Days of Beautiful Village" based upon the results of the excavation work at Pueblo Bonito from 1921 to 1927. This is followed by a brief history of the American Indian and our national archeological monuments, some 18 in number. Other prehistoric ruins in the United States are described. The excellent photographs of Devereux Butcher preserve for all time these prehistoric ruins in America.

GRETA OPPE
Ball High School
Galveston, Texas

Indians of the Longhouse. Sonia Bleeker. 160 pp. $2.00. William Morrow and Company, Inc. New York. 1950.

The saga of the Six Nations of the Iroquois is here presented as a factual story for young children. Yet the book is just as interesting as the fictionalized and extravagant versions of the Iroquois found in the tales of James Fenimore Cooper. The reading difficulty of the book would place it within the level of understanding of the average fourth or fifth grader.

Indians of the Longhouse consists of six chapters dealing with the general culture of the tribes of the Six Nations, their life and activities during the four seasons of the year, and the cultural status of these Nations as it evolved from the period of the Revolutionary War to the present. The book could hardly be construed as a reference for providing abundant factual material for elementary science, or for that matter, any other single field in the elementary school. But it is very likely that it would provide an interesting approach for the study of certain aspects of the geography of New York State, or for a unit dealing with the daily activities of the Indians in the various climates of Upstate New York.

There are a number of scientific facts integrated interestingly with the lives of the Indians, namely the use of products of trees for food, shelter, and transportation; the use of animals for food, clothing and shelter; and the means used for obtaining the most from a primitive knowledge of agriculture.

Viewed from the aspect of an organized textbook, it has certain weaknesses. At times the smoothly-written story of the Iroquois is interspersed with Indian legends that add little to the factual material offered. Further, the last chapter covers a period of about 20 years per page. In some ways the latter chapter seems to diverge from the theme of the earlier five.

There is, however, much to indicate that younger children will "eat it up."

GEORGE G. MALLINSON
Western Michigan College of Education

Ruby Throat—The Story of a Humming Bird. Robert M. McClung. 48 pp. $2.00. William Morrow and Company. New York. 1950.

Every morning Ruby Throat was up with sun's first rays and off to the meadow. He was only three and one half inches long and weighed just over two grams, which really is less than the weight of a penny. Although tiny, he had a strong little body and sturdy wings, which helped him fly faster than 50 miles an hour.

All through the long summer Ruby Throat had many exciting adventures. He was always busy and very happy until one autumn day when the trees were ablaze in hues of red and crimson and the air was turning chilly from the cold, fall rains. Ruby Throat was shivering and quite uncomfortable. He knew that he must leave for his winter home hundreds of miles away. Once more skimming the meadow, he started on his long journey to the southland. After many days he found himself in the warm sunshine of Georgia, just about half way to his final destination. Then on and on, over orange groves and palm trees, he flew until he reached the blue waters of the Gulf of Mexico. After a short rest there, Ruby Throat took off again over the miles of water and finally arrived at his winter home in Central America.

This delightful little story portrays the varied adventures of one year in the life of a humming bird. Although its language is simple, the words unfold a continuous picture of action and color. Each page is attractively illustrated, many in color, and the type is large. The content and pictures reveal a wealth of accurate information, for the author-artist, Robert M. McClung, is a scientist and assistant in the Department of Mammals and Birds at the New York Zoological Park.

GRACE E. KOERNER
Seth Boyden School
Maplewood, New Jersey

Just Off the Press—

The Teaching of Science in Public High Schools, just released by the Office of Education, is the first thoroughgoing report on the status of science teaching in the states in nearly 20 years. Prepared by Philip G. Johnson, specialist for science with the Office of Education, the bulletin will be of special interest to those responsible for curriculum development, teacher training, and research in areas of science instruction. Science teachers who want to keep abreast of professional developments will find information on new courses in the various school systems of the nation, current trends, enrollment by courses, and problems related to science teaching in the various types and sizes of high schools.

The report is 20 cents a copy and may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

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Meetings and Conferences

It's Cleveland in December—

Program committees of NSTA and other cooperating science teaching societies have almost completed plans for the four-day meeting in Cleveland, December 27–30. With joint sessions scheduled for Wednesday, Thursday, and Friday mornings, there will be separate sessions of NSTA, ANSS, and NABT each of the afternoons. Complete program details will be printed in the December issue of *The Science Teacher.*

Highlights on the NSTA sessions include an earth-biological science program on Wednesday, a physical science program on Thursday, and the fourth national conference on industry-science teaching relations on Friday. There will be an organizational meeting of the new NSTA Business-Industry Section the evening of Friday, December 29.

A Saturday morning symposium arranged by the AAAS Cooperative Committee on the Teaching of Science and Mathematics and an afternoon symposium on the National Science Foundation are recent additions to the program.

The AAAS annual science exposition is promised to be "worth a trip to Cleveland" just for this. A high spot of the exposition will be the American Museum of Atomic Energy exhibit, part of which is a model of an atomic pile. The science theater will also be high on the science teacher's "must see" list.

The Statler Hotel will be headquarters for the science teaching societies and the location of most of the sessions. Now is the time to send for hotel reservations. Write to Miss Louise D. Perkins, director, Cleveland Housing Bureau, 511 Terminal Tower, Cleveland 13.

Science Teaching Exhibition

The NSTA Committee on Apparatus and Equipment is planning an exhibition of science-teaching ideas, apparatus, and equipment for the Cleveland meeting. This will be the opportunity for all science teachers (both members and nonmembers of NSTA) to display any special teaching ideas or methods they may have developed. All such material as home-made or improvised apparatus, charts, pictures, models, diagrams, and maps will be welcome from all teaching levels. John Habat heads the local committee on exhibits.

The exhibition will be on display in the Statler Hotel from Wednesday noon, December 27, through Friday, December 29.

There is still time to enter this exhibition. Ideas or gadgets that have helped you will help others. Alert teachers are always looking for better ways of presenting lessons in science. No idea is too simple or elementary. Moreover, your exhibit may influence some manufacturer or publisher to make your idea commercially available with royalty to you.

Send a brief description of your proposed exhibit to the chairman of the committee without delay: Dr. Walter S. Lapp, 724 Derstine Avenue, Lansdale, Pennsylvania. State the general nature of the exhibit, its purpose, the area required, and indicate whether the electric current will be needed.

And It's San Francisco Next Summer—

Just another reminder to begin planning now to attend the 1951 NSTA summer meeting in or near San Francisco. Scheduled for about the last week in June, a wide array of offerings is being planned: professional programs, an industry-science teaching conference, possibly some workshop courses, and, of course, recreational and entertainment features. More complete information will reach you through *The Science Teacher* in an early issue. But place the date on your calendar now.

National Conference for Mobilization of Education

Plans for tying American education into the new defense program of the nation were discussed at a National Conference for the Mobilization of Education held in Washington, September 8–10. (See Editorial, page 159.) Representatives from 75 educational organizations voted to set up the conference as a permanent clearing house for information on defense developments and manpower policies. The conference will also work with the U. S. Office of Education in an advisory capacity.

A member of the conference, NSTA will receive copies of all future bulletins and news releases. The significance and implications of such information for science teaching will be relayed to you through the pages of *The Science Teacher.*

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BASIC SCIENCE

A NEW TEXTBOOK IN GENERAL SCIENCE

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J. DARRELL BARNARD
Professor of Education
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Experimental Science

(*Continued from page 166*)

The core curriculum development is in the forefront of curricular growth in the public schools of the United States. Concerned as it is with the basic education for all students and with learning activities for these students, it constitutes a most promising medium for the growth of experimental work in the field of science.

There is a widespread use of science clubs by the secondary school. The objectives and procedures vary somewhat, but the general pattern tends to encourage activities which, in the past, have not been considered appropriate for class work. These activities have included individual and group project work, as well as investigations which have certain qualities of research. There are a few competitive activities, such as the Science Talent Search, upon which scholarships to college are based. In these endeavors the research potentialities of the students are assessed partially through demonstrated competence in the form of projects or investigations which they have carried out.

There is a general movement toward experimental teaching in the elementary and secondary schools of the United States. It is steady but not rapid. A continuing thread of effort to functionalize learnings in science by avoiding undue abstraction and through the use of real situations may be seen. There is evidence of growing concern and effort to use real things and to employ direct experience upon which generalizations and abstractions may be formulated. Within the framework of traditional subject matter headings, fundamental units or problems of human concern serve as centers of group activity around which class and laboratory activities are organized.

In some schools the reorganization of subject matter offerings may take one of several forms: correlation of existing courses, integration of two or more areas of science, or an integration of desired basic experience for all students in the form of a core curriculum. In each of these, teachers have found opportunity and occasion to provide for experimental science in ways that traditional patterns of subject matter with their accompanying traditions have failed to yield.

The use of out-of-class situations, such as clubs, appears to be an effort to serve whatever values are found in traditional patterns of organization and to provide for direct experience as well. That it is at least partially satisfactory is evidenced by the growth in the number of clubs, the number of students participating, the quality of the club work, and the enthusiasm of the students and teachers alike.

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You May Wish To Examine—

THE CHEMCRAFT SCIENCE CLUB HANDBOOK and CATALOG. Publications, kits, and apparatus and chemicals are listed. 1951 edition; 10 cents. The Porter Chemical Company, Hagerstown, Maryland.

THE POLAR RECORD. A bulletin issued in January and July every year and devoted to full and authoritative accounts of polar exploration and research, both past and present. To receive copies regularly, write to: Assistant to the Director, Scott Polar Research Institute, Cambridge, England. 50 cents a copy.

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THE "SUPER SNIFFER." A new geiger counter just announced by Nuclear Instrument and Chemical Corporation of Chicago. This model operates on two flashlight-type dry cells. Information on request to the NICC.

CEBCO FILMGUIDES. Published by College Entrance Book Company, 104 Fifth Avenue, New York 11. Correlated with the publisher's "Discovery Problems" workbooks, these little booklets are designed to provide "the missing link" in audio-visual education. They take the student through stages of *preparation, check-up, follow-up* and *integration* for a large number of films in common use. There is a teacher's manual for each of the booklets.

THE FLUORETER. A new source of ultraviolet light for use in the classroom, laboratory, and on field trips in the study of fluorescent properties. Models available for operation from flashlight batteries or 60-cycle, 115-volt sources. Literature on request from the manufacturer: Menlo Research Laboratory, P. O. Box 522-GJ, Menlo Park, California.

SCIENCE LIAISON. Description and explanation of the field scientific liaison work of UNESCO, growing out of recognition of the fact that "science is one of the most international of all human activities." United Nations Educational, Scientific and Cultural Organization, 19 Avenue Klebér, Paris 16. 68 pp.; free.

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UNITED STATES CIVIL DEFENSE. Report of the National Security Resources Board presenting a plan for organizing the civil defense of the United States. This 162-page book outlines the organization and techniques which should be developed by state and local communities on whom rests the primary responsibility for civil defense. Also included is the recommendation for a basic civil defense law, the establishment of a Civil Defense Administration, and the appointment of an administrator. Superintendent of Documents, Government Printing Office, Washington 25. 25 cents a copy.

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A SALT-WATER-PROOF CLOTH SURVIVAL CHART and INSTRUCTION SHEET as used for navigation purposes by raft-riding Navy pilots during World War II. Part of the war surplus, the chart has recently been declassified and can be exhibited publicly and used in schools. Only 700 of the charts are available, and they will be sent to the first 700 teachers writing to Lieutenant Frances E. Biadasz, Office of Public Relations, Department of the Navy, Washington 25.

Teach the Truth!

Every science teacher will teach some form of atomic energy this year. This subject has been added to the curriculum by life—and death. The job will be done by those best armed with facts. The Atomic Energy Commission, aware of the necessity and scarcity of dependable information has authorized publication of

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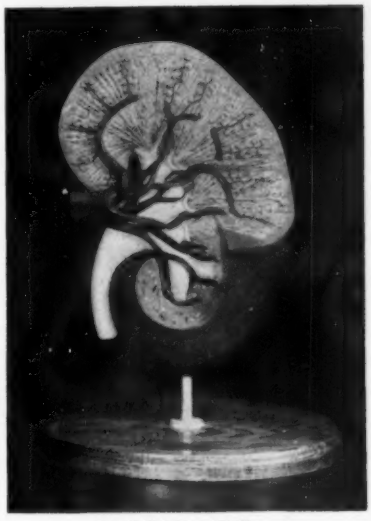

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